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SCIENCE

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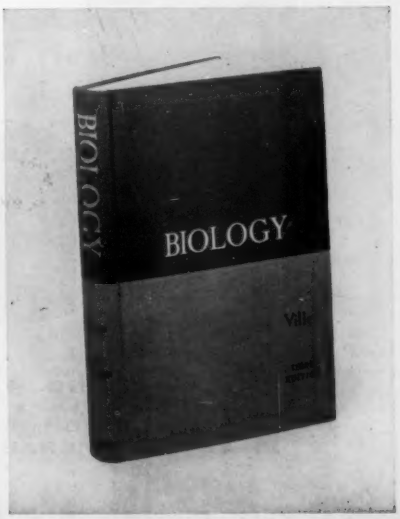

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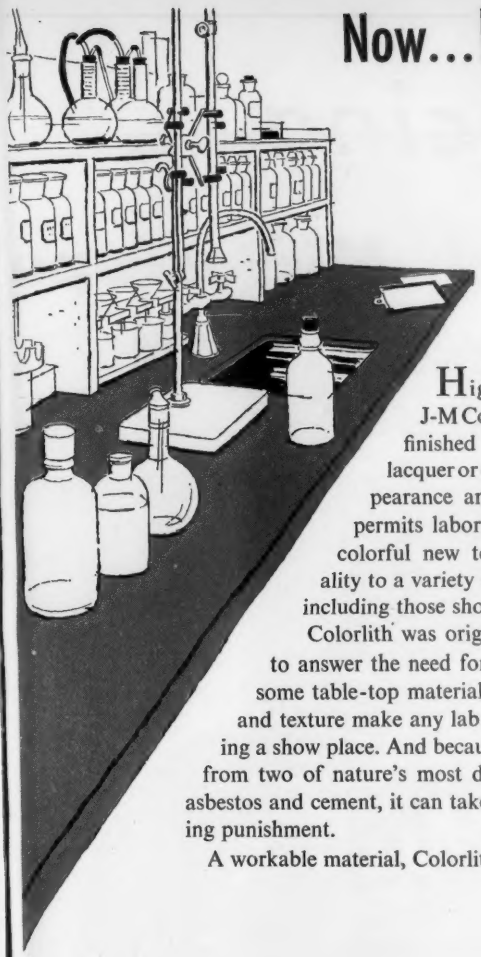

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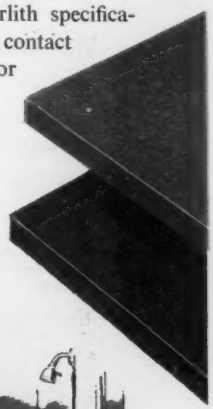

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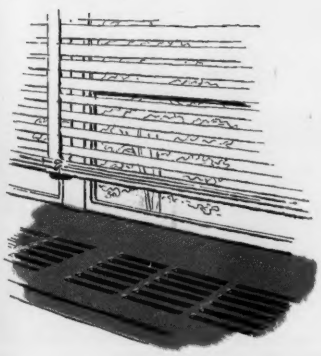

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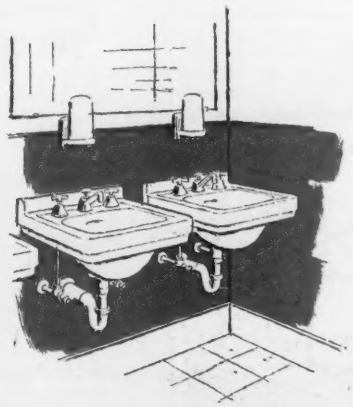

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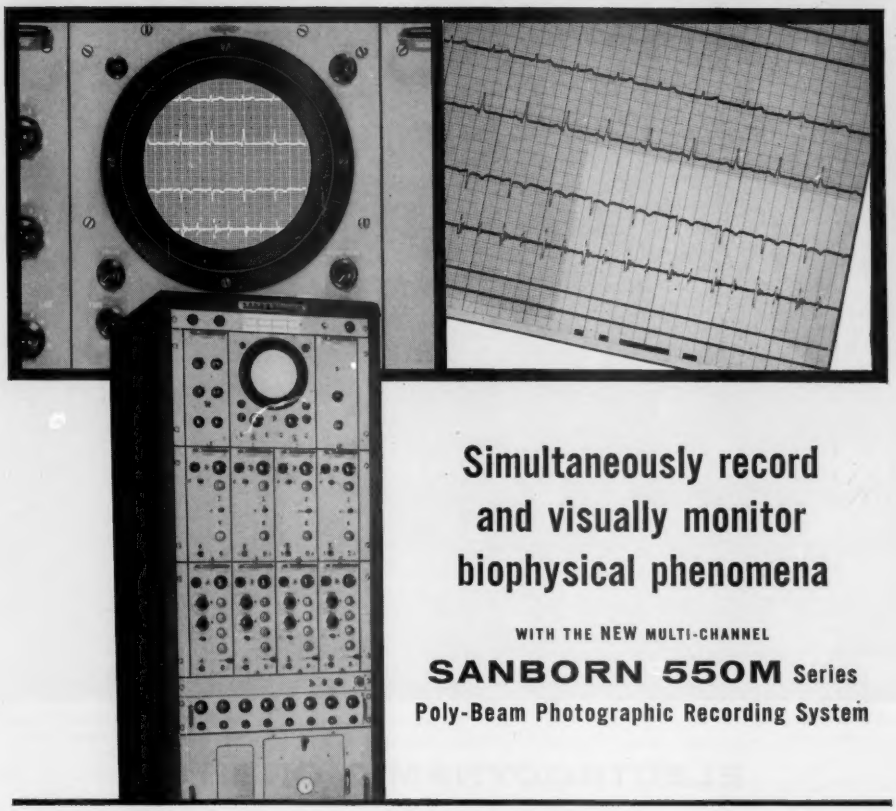

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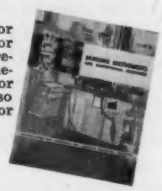

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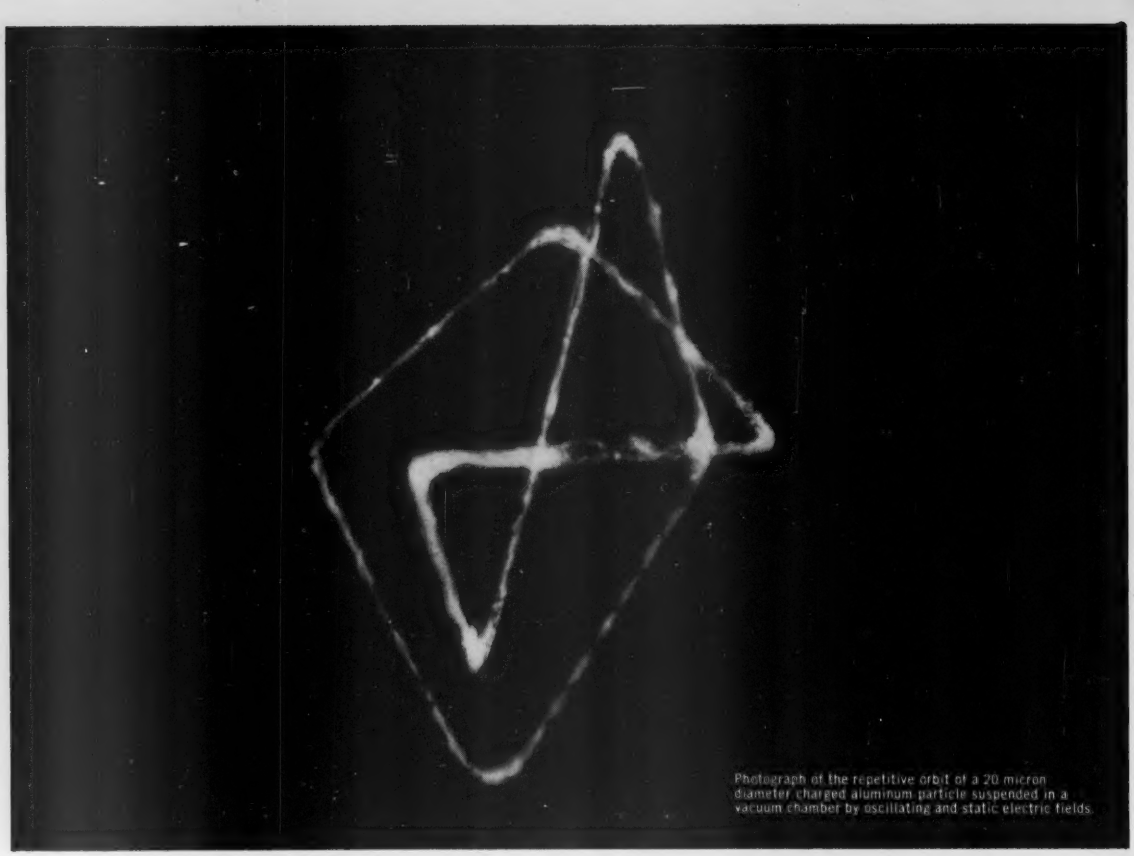

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Fellows. From Where? To Where?

In selecting the students on whom we pin our hopes for future scientific leadership, ability, as best we can measure and predict it, is surely the factor to which we should give greatest weight. Thus, in many of the most respected fellowship programs selection is made on the basis of ability alone, without regard to other considerations.

If selecting fellows for this or the next few years were the only problem to consider, ability would suffice and we would not have to consider other aspects of fellowship programs. But there are also the problems of increasing the total supply of potential fellows, and of multiplying the sources from which they come and the institutions at which they can profitably continue their studies. The selection of fellows on the basis of ability alone, and from the nation as a whole, does little to help solve these problems. Some critics even contend that the problems are aggravated by an unduly high concentration of talent in a few outstanding institutions. There has long been wide agreement that the existence of some universities of very high quality is good for all universities. Exceptionally high quality is not only good in itself but has the additional value of providing models for other universities to emulate. But if the best institutions are to serve as effective models the others must be able to follow; those that straggle too far behind lose sight of the leaders.

Thus an argument can be made for awarding some fellowships to students who are the best in their region or university, even though not the best in the nation. It is this argument that prevailed when the fellowship provisions of the National Defense Education Act of 1958 were drawn up. Those provisions were designed to increase "the facilities available in the nation for the graduate training of college or university level teachers and of promoting a wider geographical distribution of such facilities throughout the nation." Accordingly, fellowships are to be awarded upon recommendation of individual universities which have made arrangements with the Office of Education for help in financing programs designed to increase the number of persons prepared for teaching in institutions of higher education.

Graduate programs may be new or may be expansions of older programs, and the programs and their accompanying fellowships may be in any field in which there is a substantial need for additional college teachers. Clearly some will be in science and mathematics.

Fellowships can be awarded for up to three years. The authorized number is 1000 during the first year and 1500 during each of the three succeeding years. Stipends will be $2000 for the first year beyond the baccalaureate degree, $2200 for the second year, and $2400 for the third year, plus in each case an additional $400 per year for each dependent.

Some of these fellowships will almost certainly be awarded to students who would not qualify for National Science Foundation fellowships, which are awarded primarily on the basis of ability and which are national in character. But that fact represents neither rejection nor criticism of the NSF program. The new program is complementary rather than competitive. NSF fellowships will continue to reward and encourage graduate students of highest promise, wherever they are found. The new fellowships, plus grants to the universities of up to $2500 per academic year for each fellow, are intended to increase the number and to widen the geographic distribution of excellent graduate students, and of universities that offer graduate work of high quality.—D.W.

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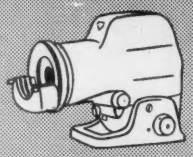

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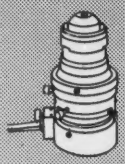

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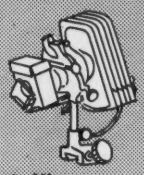

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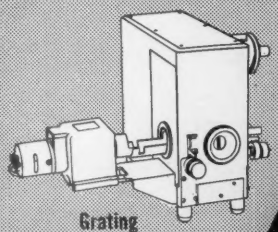

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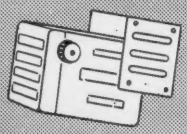

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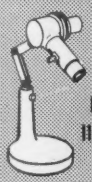

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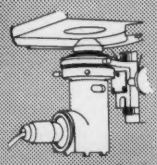

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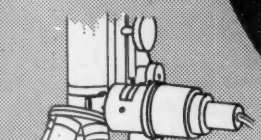

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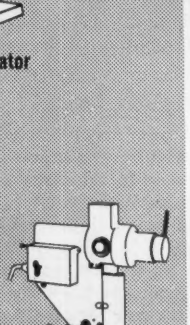

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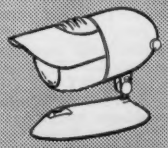

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Problems in the Statistics of Urban Agglomeration

The growth of urban areas has made necessary new concepts and reformulations in social statistics.

Stuart A. Rice

Objects and other conceptual entities are classified according to criteria that command notice or seem important. These criteria tend to differ from group to group, to change with time, and to be supplanted when their significance disappears. Sometimes an evolving entity has changed so much that it seems useful to place it in another class, though this may be a matter of opinion. Henri Pirenne, in his 1922 lectures in America, raised this question respecting the city. Referring to Western Europe in the ninth century, he asked whether cities existed at all "in the midst of that essentially agricultural civilization." The answer depended "on the meaning given to the term 'city.' . . . The cities which were then to be found were without two of the fundamental attributes of the cities of the Middle Ages and of modern times —a middle-class population and a communal organization. . . . The period which opened with the Carolingian era knew cities neither in the social sense, nor in the economic sense, nor in the legal sense of that word" (*1*).

Ivar Oman, director of the Stockholm Office of Statistics, describes the Western European town of a thousand years ago as an enclosed and compact settlement with a detailed network of streets (*2*). Its criterion was "that it formed its own market, administered justice in its own courts . . . and was free to determine its affairs in important matters. By and large, he believes, "these criteria still hold good," despite an astonishing growth in city size. Oman notes that "great cities in the modern sense did not exist in the Middle Ages nor at the beginning of modern times." The German scholar Konrad Olbricht placed in the class of "great cities" 17th-century towns with 15,000 inhabitants and 18th-century towns with 20,000 inhabitants.

Cities and Towns

In America the incorporated municipalities of a century ago were substantially identical with urban areas. The identification and demarcation of cities and towns thus offered no difficulties to census takers, statisticians, or city dwellers themselves. By contrast, to illustrate present needs for new criteria of classification, let us compare Falls Church, Virginia, with the "largest city in the world."

Falls Church is known to many residents of nearby Washington, D.C., as a vaguely defined section that interposes a traffic bottleneck on the way to the Virginia Skyline Drive. The incorporated city of about 2 square miles and some 10,000 inhabitants is rarely distinguished from East Falls Church, a section of Arlington County; from West Falls Church, within its own boundaries; from the Falls Church District of Fairfax County, with some 20,000 or 30,000 population; or from the area served by the Falls Church post office, an area containing, perhaps, 60,000 people, all of whom use Falls Church as their postal address. To add further confusion, the city's own high school is outside its boundaries, in Fairfax County, a wholly separate jurisdiction in the Virginia setting, while "Falls Church High School," located within the city, is a property of Fairfax County and subject to that county's jurisdiction.

If the identity of Falls Church is obscure, even to many residents, the "largest city in the world" is virtually unknown in this country. In area it is 12 times as large as Los Angeles and 2729 times as large as Falls Church, but has only about three times the population of Falls Church. This "city" is Kiruna, Sweden. It includes within its municipal boundaries iron mines, the highest mountain in Sweden, and much of the northern territory of that country. By legal definition Falls Church and Kiruna are both "cities," with taxing and administrative authorities. In other respects they have little comparability. If attention is shifted from public administration to the demographic, social, and economic realities with which urban life is increasingly concerned, it seems clear that legal status as a municipality is no longer adequate as a statistical criterion for the classification of spatial groupings of people. New criteria are developing new conceptual units, and the end is not yet visible.

In the Western world, particularly in the United States, life has become adjusted to motor transportation. The automobile sometimes seems as important to individual and family life as the home. Yet the first indications of basic changes in the conceptual units needed for statistical descriptions of urban areas preceded the age of Henry Ford. Leon Schnore points out that "at the turn of the twentieth century most urban cen-

The author is president of the Surveys and Research Corporation, Washington, D.C. This article is based on his vice-presidential address to Section K, AAAS, on 27 December 1957 in Indianapolis, Ind.

ters were still rather compact and self-contained entities." However, ". . . railways—powered by steam or electricity—spread out from the largest cities in radial strings, and along their lines began to appear clusters of dwellings," the occupants of which were in various ways related functionally to the city (*3*).

It was in the census of 1900 that the Bureau of the Census, with remarkable prescience in its adaptation to change, for the first time defined a new demographic unit, the "metropolitan district" (*4*). As cities increasingly emptied or attracted inhabitants into surrounding areas, the use of this new concept as a statistical unit for all manner of social and economic analyses gained momentum. It is not improbable that "standard metropolitan areas," successors to "metropolitan districts," now outrank "cities" in statistical importance. Indeed, the Bureau of the Census is considering for the 1960 decennial enumeration a primary dichotomy between metropolitan areas and nonmetropolitan areas for classification of the nation's population.

If evolutionary processes could be halted, it is probable that the principal areal and demographic units now employed in statistics of urban areas would suffice for most administrative and analytical purposes. But urbanizing trends are dynamic. There is unlikely to be a pause in the social and economic metamorphoses to which they are leading. Oman describes the "modern great city" as having "broken through the boundaries of the traditional type of town. . . . [Its] very structure has come to differ radically from the formation of towns in the past. . . . The great city has become the focal point of what might be called an urbanized area, a mixture of country and town, a diffuse mass with neither beginning nor end."

Another aspect of this evolution is "the town attached to the road." This has been described in vivid language by Dan Jacobson, a South African newly arrived in the United States. He writes:

"The town seems to be the no man's land, not the road. Except for a house to live in, that road along its length is able to provide you with any material thing you might ever need. There are banks, travel agencies, money lenders; real estate agents . . . and furniture stores . . . bookstores and shops selling . . . records . . . little establishments that offer you fish in bowls . . . at least three or four hospitals for dogs. But the curious, the frightening thing is that no one lives on the road; all these shops and facilities belong only to the road and to no city. Nowhere along its length does the road contract, confine itself, center itself for a community around it. . . . It is as if some kind of vital tendon has been severed, so that it can grasp nothing to itself, can enclose nothing in itself, can make no order of itself, but can only lie sprawling, incoherent, centerless, viewless, shapeless, faceless—offering all the products a community can need and yet making the establishment of a community impossible" (*5*).

Neither Oman nor Jacobson is describing the "urban agglomeration" of the future but only its present, imperfectly developed embryo. The matured phenomenon of which they see the beginnings may be more than urban, more than metropolitan, more than a great city or metropolitan area. Even under the definition of metropolitan districts employed in the 1930 census, which rested mainly upon the presence of central cities of 100,000 or more population and the population density of minor civil divisions adjacent to them, it would have been "possible to proceed from the state line of Maryland to the state line of New Hampshire leaving the area of a metropolitan district only twice for a total distance of less than 16 miles" (*6*).

Jean Gottman, director of the Study of Metropolitan Areas by the Twentieth Century Fund, refers to the superagglomeration that is forming along the North Atlantic seaboard of the United States as "megalopolis" (*7*). He defines it as "a cluster of metropolitan areas with several downtown nuclei corresponding to the conventional meaning of the word city." He thus adds some precision to a recent newspaper editorial entitled "A Virginia-to-Maine Strip City" (*8*).

Mixture of Country and Town

It is uncertain that even this vast conception will fully satisfy the need for a statistical term to describe the agglomerations of the future. Gottmann states that ". . . today there are no longer any clear-cut limits which separate 'town' from 'country.'" This fact is implicit in the employment by newspapers or broadcasting stations, to describe their areas of coverage, of such vague terms as "Chicago-land," with the rather indefinite inclusion of major portions of whole states within them. The use of such terms is supported by the disappearance of many of the differentiated aspects of urban and rural living which distinguished "city slickers" from "hayseeds" for our great-grandparents. City workers may enjoy many of the pleasures of country living during portions of the year, or even in their daily living, while farm dwellers, whose economic life increasingly resembles that of manufacturing or extractive industry, possess many of the cultural attributes of urban society, such as communication over wide areas, ready transportation, and recreational facilities.

Oman cites as problems posed to community planners and statisticians, first, the coordination of statistics on the various parts of the urban agglomeration; and second, the delimitation of the sphere of influence around a great city. With respect to the first, American sociologists and demographers have taken the lead in studies of the structure of agglomerations and the relations among their parts. New concepts, subordinate or ancillary to the concept of the metropolitan area, such as "urbanized area," "central city," "central business district," "suburb," and "suburban fringe," are being defined with increasing precision.

Oman's second problem leads to others related to the "mixture of country and town." Do we perhaps need to delimit a series of zones, extending *beyond* the metropolitan area, the urban agglomeration, or "megalopolis," within which urban influences directly affect the social and economic structure? Such zones might reflect either the kind of influence or its degree. In 1933 I suggested that the "metropolitanism" or "urbanity" of a population "might be regarded as variable." "Urban" and "rural" might cease to be discrete concepts and "become relative terms—calling in each case for a specification of the degree of urbanity or rurality" (*9*).

Notable among pioneer studies pointing in this direction were those about the beginning of the 1930's by Horace Secrist, director of the Bureau of Business Research of Northwestern University. Trading areas of different types were differentiated. They were centered all the way from neighborhood markets for the purchase of groceries and school pencils to the metropolitan marts with far-flung clientele for such commodities at retail as expensive clothing and (it could have been added) stocks and bonds. Secrist's conceptions, borne out by his findings, were undoubtedly influenced by the conception of gradients in urban phenomena, developed by McKenzie, Burgess, and others at the department of sociology of the University of Chicago.

Statistical Issues

I remain somewhat overwhelmed by the immense variety and complexity of the statistical issues to be faced in a changing society, even in a single country—the United States. The subjects upon which data will be needed will not differ greatly from those now elaborated in many familiar statistical sources. We will still need information on such economic phenomena as employment, wages, income, agricultural and industrial production, distribution, prices, and finance, as well as on demographic and vital phenomena, health, education, and other indicators of social structure and welfare—all, as at present, in great detail. The predictable statistical changes will be less in subject matter than in the demographic units of statistical classification and in the over-all structure of organization.

A greater volume and specificity of local data will be needed as urban agglomerations continue to expand. These data will be directed toward the solution of types of issues that have already appeared in our larger metropolitan areas, especially in those which embrace two or more state jurisdictions. Such issues are under study by the Joint House–Senate Committee on the Washington Metropolitan Area. The committee has tabulated the problems most often mentioned "by area public agencies as the most important facing the group." In order of frequency of mention, these are mass transportation, highways, recreation and park acquisition, sewage disposal, water supply, land-use zoning, silt and industrial water pollution, lack of authoritative planning, school shortages, hospital problems, taxes, public housing, special problems of the District of Columbia, parking, and taxicab regulation. Although not mentioned by that name, urban renewal clearly belongs in the list.

Most of these issues will be found in other metropolitan areas. They will continue to exist, in even more exaggerated form, if, as allegedly predicted by Jerome Pickard of the Washington Board of Trade, the Washington and Baltimore areas are ultimately consolidated in a single gigantic city of 8 million people (*10*).

Greater emphasis upon local data will have to be reconciled with pressures for information of national scope. These pressures will continue to increase as national economic and social organization, both in the public and private sectors of the economy, continues to expand. With local and national statistics both gaining in relative importance, a relative shrinkage can occur only in the availability of data related to the traditional administrative jurisdictions of our political system below the Federal Government—states, counties, and incorporated municipalities.

Demands for information pertaining to cross-cutting areas under special and *ad hoc* jurisdictions—port authorities, transit commissions, sewer districts, and official planning bodies, for example—and for information for unofficial bodies such as regional planning counsels, will lead to a proliferation of statisticians and statistical activities. "Municipal" statistics have never received in the United States the extensive specialized development and recognition given them in Europe. Bypassing their development, here we may anticipate the emergence of "urban statistics" as a major subdivision of the statistical field. Uniform national patterns for obtaining much of the data needed by special and *ad hoc* agencies will be absent. These agencies will depend increasingly upon their own statistical personnel and facilities rather than upon those of the Federal Government. A tendency toward the decentralization of statistical responsibilities from Washington, along with a needed clarification of the respective responsibilities of national and local statistical agencies, may result.

To Washington, however, the public must continue to look for basic data pertaining to the population, its distribution and its use of the earth's surface. Most statistical information is directly or indirectly based upon the population census. The decennial population and housing census may well become quinquennial, as statisticians and sociologists have urged for upward of a quarter of a century. It will be supplemented by expansions of the monthly "current population survey," an invention of depression years, to give more information on more subjects on a sample basis.

The demand for information on population and housing by small and stabilized area units, already great, will continue to grow as urban agglomerations are widened. Aggregates for many varied combinations of small areas will be compiled for the numerous special studies undertaken by official jurisdictions and unofficial planning bodies that cut across traditional administrative boundaries. The statistical "building blocks" needed for this purpose have already been created and put to use in most of the larger cities and throughout some of the metropolitan areas of the United States. "Census tracts" consist of small areas, coinciding where practicable with the boundaries of administrative jurisdictions or electoral districts but relatively independent of changes in these. They are intended to remain constant from year to year and from survey to survey. As primary units for statistical summation they make possible comparability among diverse data and the measurement of changes in demographic, social, and economic structures over a period of time. Most cities of 50,000 or more population and all metropolitan areas with central cities of 100,000 or more population have now been divided into tracts by local initiative with federal review and approval. The total of 12,500 tracts in 1950 has already been raised to some 22,000. When the process of division into tracts has been completed, to include all of the territory which is urbanized, or is likely to become urbanized, or is affected by the proximity of agglomeration, then a statistical portrayal in census terms of the growth of a "Virginia-to-Maine strip city" will become a simple problem of arithmetic. Statistical studies of problems of the types that concern the House–Senate Committee on the Washington Metropolitan Area will be facilitated. A more precise definition of the extent and character of the influences exerted by urban agglomerations upon surrounding territory, including delimitations of those influences, will become possible.

A second type of statistical "building block" now in use and subject to greater development in the future is the city block itself. The practical utility of use of city blocks is found in urban areas of high population density where sharper delineations than census tracts are needed for urban renewal and slum clearance programs and for correlations among housing conditions, health, delinquency, and other social phenomena. City blocks are also useful for certain marketing studies and for use in the stratification of samples. Block statistics have lesser utility in loosely built residential areas.

Population mobility, as compared with place of residence or abode, will receive greater emphasis in the future. Functional differentiations are magnified in an expanding urban agglomeration, and related problems of transportation and communication will give greater importance to the movements of people within it. Daily movement of population, or its absence, is not always a function of com-

munity size. Nevertheless, the prevailing pattern of urban living for an increasing number of adults involves a principal division of time between place of abode and place of work, with growing distance between the two and between either of them and places of marketing and recreation. The character, direction, and extent of the incidental transportation are ancillary data of crucial importance to planners and analysts of urban problems.

Each of two statistical approaches to the relatively new phenomenon of separation between residence and work may serve a different group of needs. For some purposes, notably for planning measures of civil defense, it seems important to know the physical location of people at various times of the day and week. The conception of "residence" is applicable to a part only—possibly a minor part—of the 24 hours in a working day. In terms of some unit of economic activity, presumably hours of employment, residence is clearly of secondary importance. Hence, it is conceivable that we may some time wish, following British census precedent, to make the place of work rather than place of abode the primary basis of classification of the adult population.

If funds were available and administrative difficulties could be resolved, a double enumeration and classification is conceivable: one enumeration at the place of residence and one at the place of work, without attempt to identify the individuals counted at the one place with those counted at the other. This would have the advantage (since information concerning workers is usually provided to census enumerators by some other member of the family) of providing much more accurate information than at present concerning the occupation, industry, and work status of the population. For any area, comparison between the resident population and the working population would indicate the net, rather than gross, diurnal movement between the two areas. In its usual laudable endeavor to adapt its schedules to the changing times, the Bureau of the Census is even now contemplating an attempt in the 1960 census to gain a gross measure of diurnal movement by interrelating residence with place of work as identified with one or another of a few broad zones into which metropolitan areas may be divided.

The second statistical approach to diurnal population mobility is to measure movements while they are in process. This approach has become familiar in the form of traffic surveys which enumerate drivers or passengers by origin and destination of trip. The utility of this type of inquiry is more limited and perhaps more ephemeral than that of a census at place of work would be. Traffic surveys have specialized value for those who must plan the extensions and interrelations of highway networks and other transit facilities.

A parallel problem of population mobility is involved in seasonal movements. The Bureau of the Census is confronted with a new puzzle in its application of even the conventional identification of place of residence: Many families now have *two* residences. Which of them is to be considered the family base for the tabulation of population totals? The direction of its thinking is indicated by the bureau's decision to record college students as residing at the place of their study.

More extensive are the annual migrations of millions of persons between seasons to take advantage of climatic differences. *Time* magazine (*11*) reports that "8,500,000 to 9,000,000 outstaters are planning to flock to Florida in the next twelve months—about 1,000,000 more than in the past year." Surely this is an important social phenomen, collaterally related to urbanism, of which statistical records must be made in a more systematic manner in the future.

The statistical response to this phenomenon seems to require a still further expansion of the monthly sample current population survey of the Bureau of the Census. Just as many time series of economic data are conceived as reflecting a variety of movements—secular, cyclical, and seasonal, in particular—the location of people may in the future be similarly conceived and measured. The official "population" of a community or area may some time require notation of the season, and even of the day and hour, and not merely of the date of the decennial or quinquennial enumeration.

A final conclusion concerns the need for statistical studies of the attitudes and plans of the people whose continued presence in close proximity creates the urban agglomeration. If we knew more about the interests, desires, and motivations which prompt people to seek residence in a particular suburb, to return from a fringe area to a downtown apartment, to drive through traffic instead of riding on the Long Island Railroad or the Illinois Central, we would obtain a better view of the forces and trends to which urban growth and planning must be adapted.

References and Notes

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5. D. Jacobson, *Reporter* (21 Feb. 1957), p. 18.
6. S. A. Rice, *Next Steps in the Development of Social Statistics* (Edwards, Ann Arbor, Mich., 1933), p. 21. The density criterion for the definition of metropolitan districts applied in the 1930 census has been replaced in considerable part by evidences of functional relationships (volume of commuter travel, telephone traffic, and so forth) for the definition of "metropolitan areas." These embrace whole counties contiguous to central cities of 50,000 or more population. In consequence, the nonurbanized territory included in "metropolitan areas" is greater in extent than that included in the "metropolitan districts" of 1930.
7. J. Gottmann, *Challenge, the Mag. of Econ. Affairs* (N.Y. Univ.), Aug.–Sept., 1957, p. 54.
8. *Northern Virginia Sun* (14 Oct. 1957).
9. S. A. Rice, *Next Steps in the Development of Social Statistics* (Edwards, Ann Arbor, Mich., 1933), p. 25.
10. There is an interesting survival in this idea of the conventional conceptions of the "city" and the "metropolitan area."
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Chemical Basis for Adaptation in Plants

Understanding of heat tolerance in plants may permit improved yields in arid and semiarid regions.

Edwin B. Kurtz, Jr.

Everyone talks about the weather, but no one does anything about it. This familiar cry for better control by man of his surroundings is being partly answered by atmospheric physicists, but a more subtle and indirect approach to the problem would be to change or supplement the biochemistry of plants and animals so that they would be better adapted to the existing environment. This is not as fantastic as it seems, for there are a few isolated bits of information in regard to temperature that show that man can adapt a plant to an environment.

The arid southwestern United States is generally characterized by inadequate water and high temperatures. In considering the adaptation and agricultural relation of plants to the high temperatures of this region, we too often think of this factor as affecting only the use and loss of water. Our attention has therefore been centered on the problem of water use by plants, and direct effects of temperature on plant metabolism have been largely overlooked. Many gross effects of temperature on photosynthesis, respiration, and translocation are well known, but the direct question, "How does a high temperature kill or damage a plant?" is seldom asked.

In 1920 the American botanist D. T. MacDougal stated that because the growth of an organism is the result of a great number of activities, temperature may control growth if a single process that is particularly sensitive to temperature changes forms either the retarding or leading process. Now, if an essential metabolic compound that is involved in the process or reaction controlled by temperature is known, then it should be possible to control the growth of the organism by supplying it with the known metabolite, even if the organism is growing under an otherwise deleterious temperature. That is, if the metabolic reaction $A \rightarrow B$ is completely or markedly inhibited at a high temperature, and B is essential for normal growth of the organism, then growth at a high temperature may be restored by supplying metabolite B to the organism. Conversely, if A is an essential metabolite and the rate of reaction $A \rightarrow B$ is greatly accelerated at high temperatures so as to deplete the supply of A, then normal growth of the organism may be restored by supplying A. This hypothesis, suggested and termed by James Bonner the chemical control of climatic diseases of plants, offers an extremely fruitful field of research in plant science and agriculture. Although the present discussion will be limited to the application of this concept to plants, the concept should be of use in the study of the ecology of certain animals, particularly the invertebrates.

Chemical Basis of Climatic Disease

The relationship between temperature and metabolites has been beautifully shown by the work of H. K. Mitchell and his coworkers on temperature-sensitive mutants of the red bread mold, *Neurospora crassa*. The so-called "wild type" of *Neurospora* has the full complement of genetic characters and grows quite well at temperatures of from 35° to 40°C. However, a mutant was found that grows normally up to 25°C, but, above this temperature shows a rapid decrease in growth until, at 28°C, no growth occurs (Fig. 1). Apparently the high temperature limits growth by controlling some essential reaction. It was soon found that the addition of only 2.5×10^{-4} grams of the B-vitamin riboflavin to each liter of culture solution restores growth of the mutant at high temperatures. Because riboflavin is a part of a coenzyme involved in the transfer of hydrogens and the conservation of energy in organisms, it is not surprising that the organism struggles for existence when the production of riboflavin is inhibited in the mutant by high temperatures.

Climatic ills of other temperature-sensitive mutants of *Neurospora* have been cured by the addition of adenine (Fig. 2) and pyrimidines. Adenine is essential for the utilization and transfer of energy in cells, and it also occurs in such critical sites as chromosomes, so that the control of its formation by high temperatures has drastic effects on growth.

Probably the earliest demonstration of the chemical control of a temperature disease in a higher plant was by J. Bonner in 1943. The vegetative growth of *Cosmos* plants is restricted by a low temperature of 20°C to one-half the optimum rate obtained at higher temperatures, but this inhibition by the low temperature can be reduced by 50 percent by the addition of the B-vitamin thiamine to the nutrient medium in which the *Cosmos* are growing. Thiamine, of course, is an essential metabolite of the *Cosmos* plant because it is part of a coenzyme in the aerobic respiration cycle.

Turning now to effects of elevated temperatures on higher plants, we may note that A. W. Galston and M. Hand were the first to show that the temperature disease of a pea plant has a chemical basis. The common pea will grow at temperatures of up to 30°C, the optimum being near 20°. However, if the plant is exposed to a temperature of 35°C for a few days, it turns yellow and dies, even though water and mineral nutrients are amply supplied. The thermal inactivation of growth at 35°C can be largely prevented by the addition of adenine to the nutrient medium. Very recently H. R. Highkin investigated heat tolerance in two genetic strains of peas —one that is heat-susceptible and one that is heat-resistant. In the heat-susceptible variety, the tissues contain equal amounts of adenine at both low (14°C)

The author is assistant professor in the department of botany of the College of Agriculture, University of Arizona, Tucson. An earlier version of this article was presented as part of a symposium on bioecology at the 1958 annual meeting of the Southwestern and Rocky Mountain Division of the AAAS at New Mexico Highlands University, Las Vegas.

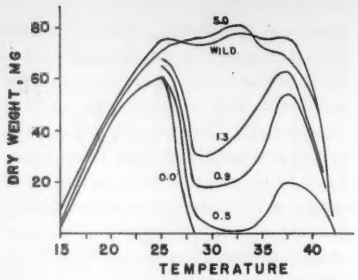

Fig. 1. Growth (in milligrams, dry weight) of the wild type and temperature-sensitive riboflavin mutant of *Neurospora* at different temperatures and riboflavin concentrations (in micrograms per 20 milliliters of culture). [Redrawn from H. K. Mitchell and M. B. Houlahan]

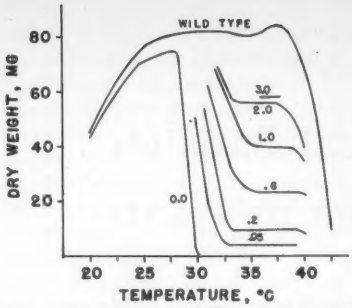

Fig. 2. The thermal inactivation of a temperature-sensitive mutant of *Neurospora* at different temperatures, and its cure by adenine (concentrations in milligrams per 20 milliliters of culture). [Redrawn from W. D. McElroy and H. K. Mitchell]

and high (26°C) temperatures, whereas in the resistant variety the amount of adenine doubles at 26°C as compared with that of plants grown at 14°. Thus, heat tolerance in peas is quite similar to that in the temperature-sensitive mutant of the red bread mold that requires adenine to cure its climatic disease. These findings go a long way to explain why the pea plant is a cool-weather crop and also suggest how it may be possible to "adapt" peas or other similar crops to cultivation in warmer environments. Although only one other plant, the common duckweed (*Lemna minor*), has been found to be protected against high-temperature damage by the addition of adenine (in the form of the sugar derivative adenosine) to its diet, the limitation of plant growth at high temperatures by the destruction of adenine may be a rather general phenomenon.

It is well known that biennial plants must receive a cold treatment at the end of the first year's growth in order that the formation of flower buds and subsequent flowering during the second year may be induced. Apparently some substance which is destroyed at high temperatures and accumulates during the cold period is required to trigger the reproductive cycle. However, no substances tested—until recently—were able to substitute for the cold treatment. Anton Lang has now shown that the new wonder compound, gibberellic acid, will stimulate a biennial plant to flower even though it has not been cold-treated. It is not known definitely whether gibberellic acid is a plant hormone and is iself formed in biennial plants at low temperatures, but in any event this intriguing compound can permit a biennial plant to reproduce in an environment that is warmer than nature intended.

These few examples of the chemical basis of climatic diseases constitute nearly all that are known, but they nevertheless suggest some interesting thoughts about the adaptations of plants in nature and the possibilities for greater control by man of his surroundings. The following comments on the high-temperature tolerances of desert plants may indicate some of these possibilities.

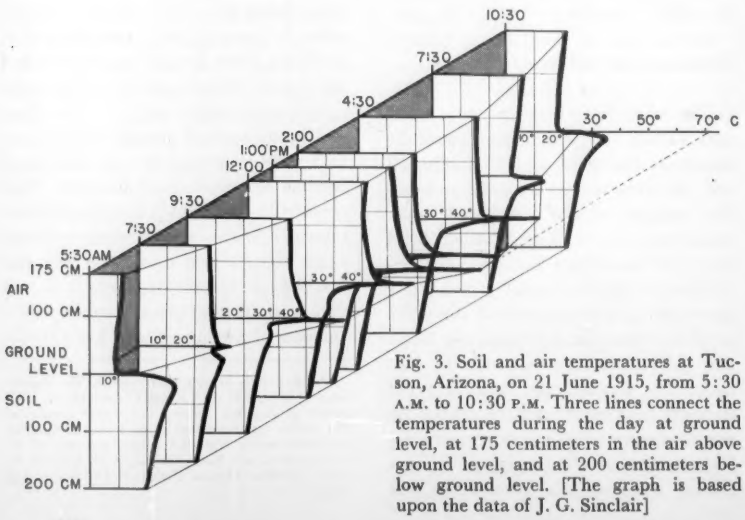

Fig. 3. Soil and air temperatures at Tucson, Arizona, on 21 June 1915, from 5:30 A.M. to 10:30 P.M. Three lines connect the temperatures during the day at ground level, at 175 centimeters in the air above ground level, and at 200 centimeters below ground level. [The graph is based upon the data of J. G. Sinclair]

Desert Plants

It is generally recognized that desert areas of the type found in the southwestern United States experience high temperatures during a large part of the year, but it is not often realized just how high these temperatures may be. On the basis of data that Sinclair obtained in Tucson, Arizona, on 21 June 1915, a three-dimensional graph was constructed to show the soil and air temperatures at various times of the day (Fig. 3). Because the maximum air temperature at 175 centimeters above ground level was only 43°C (109°F), which is not an exceptionally hot day for this area, the values given should not be considered the maxima that plants and animals must tolerate. Even so, of special note are the extremely high temperatures at or near the soil-air interface. On the particular day studied, the soil surface heated up to 71.5°C at 1:00 P.M., and the region between 4 centimeters above and 4 centimeters below ground level remained at a temperature greater that 40°C for about five hours. Such prolonged heat is not a rarity in desert regions of the Southwest but is of almost daily occurrence from May to September or October of each year.

As might be expected, plants that are indigenous to the desert region are remarkably tolerant of high temperatures. D. T. MacDougal and E. B. Working, of the now extinct Carnegie Desert Laboratory, Tucson, observed that stem joints of young *Opuntia* cactus grow at an air temperature of 58°C. Growth ceases when the air temperature reaches 63°C and the internal temperature of the joints is 62°C. However, joints exposed to these high temperatures resume growth immediately upon "cooling" to 50°C. Other workers at the Desert Laboratory found that the roots of the creosote bush, a plant which is known to flower and set fruit during a drought and heat spell lasting several months, have their maximum growth rate at temperatures of from 30° to 35°C, and the rate

of growth at this temperature is ten times that at 20° to 25°C. The roots of mesquite, another common desert shrub, have their maximum growth rate at a temperature of 36°C and grow nearly as rapidly at 41.5°C. As shown in Fig. 3, these temperatures do actually occur in the upper regions of the soil, and many desert plants have the majority of their roots in this region.

The seeds of desert plants are even more remarkably tolerant to high temperatures. In our work with the giant cactus or saguaro, we were not too surprised to find that the dry seed was still viable after being cooked continuously for seven days at 83°C. Such heat resistance is essential for survival of the cactus, because the seed must be able to tolerate extremely high temperatures for days or weeks as it lies on the soil surface waiting for a rain to set the germination process into action. And this is not an isolated example, for Faith Poole found that the seeds of three desert shrubs—ironwood, mesquite, and blue paloverde—also remain viable after exposure for six hours to temperatures up to 82°C on four consecutive days. Obviously, not just the seeds of these plants are able to survive the high temperatures encountered at the soil-air interface; the tender seedlings and young plants also must be extremely heat-tolerant.

Implications

Unfortunately, no mechanisms are yet known that explain the ability of desert plants to prevent heat damage at the high temperatures in which they must live. Nevertheless, the few examples given here in support of the chemical basis for heat tolerance suggest a new approach to the study and understanding of desert plants. From an agricultural viewpoint, research along these lines may permit increased yields of crops or even the cultivation of economically desirable plants in areas that normally would not support their growth. The arid and semiarid areas of the earth account for more than one-third of the total land surface, and many of these regions not only are arid but also have high temperatures. As a consequence, the agriculture of these areas is restricted to a relatively few plants, often with poor yields. There is, then, the possibility that a knowledge of how desert plants tolerate high temperatures, and the use of this information for the chemical cure of climatic ills of economic plants, will help to solve the critical food problem of the world by permitting agriculture to extend into new lands and by increasing yields of presently cultivated areas. There is much to be understood about the plants and environment around us, but the concept that temperature damage of plants has a chemical basis, as actually demonstrated experimentally in a few cases, offers a new and fascinating avenue of exploration.

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University of Michigan Radiocarbon Dates III

H. R Crane and James B. Griffin

The list of 94 dates shown in Table 1 is a continuation of our previous lists (*1*). The introductory statements concerning the method of measurement and the meaning of the stated limits of error given in list II (*2*) apply to this list also.

Since this is our final list to be published in *Science* (*3*), and since we have not previously included more than a brief mention of the technical method, it seems appropriate at this time to give a somewhat more complete statement about the technique we use.

We use a CO_2-filled counter, which is operated in the Geiger, rather than the proportional, voltage range. The envelope is a copper tube of 3-inch inside diameter and 22 inches total inside length. The anode wire is of 0.005-inch platinum, and is 14 inches in active length. There is a cylindrical grid 2¼ inches in diameter, composed of 0.01-inch copper wires spaced ¼ inch apart, situated concentrically with the anode and cathode, and extending well beyond the active region at either end. The grid normally has a potential of about 150 volts positive with respect to the cathode, and it is pulsed to about 1000 volts positive with respect to the cathode to quench each discharge. The active counting region extends radially all the way to the cathode surface, inasmuch as the grid is at a positive potential. The counter is filled to a pressure of 74 centimeters of mercury by admission of 3 centimeters of CS_2 vapor, 3 centimeters of hydrogen, and 68 centimeters of CO_2. The counting threshold is at 5000 volts, and the plateau extends to about 5400 volts. The anticoincidence ring consists of eight 2- by 20-inch copper, neon-filled Geiger tubes, in a single layer around the CO_2 counter. The tubes are connected in parallel and are operated with a univibrator type quench circuit. We have found that the use of the external quench is a worthwhile economy. Tubes give perfect performance in externally quenched operation far beyond the time that would mark the end of their useful life as self-quenched counters.

We find that the CO_2-CS_2 Geiger counter has an advantage and a disadvantage, in comparison to the pure CO_2-

Dr. Crane is professor of physics at the University of Michigan, Ann Arbor. Dr. Griffin is director of the Museum of Anthropology at the University of Michigan.

filled proportional counter used by most other laboratories. If a CO_2-filled counter is to be operated in the Geiger range of voltage, the addition of a "quench vapor" is necessary. CS_2 works admirably, giving the counter a long flat plateau, and producing very stable operation. However, the electrons released in the gas by the disintegration of the C^{14} or by other radiation do not remain free as they move to the anode, but attach to molecules (presumably the CS_2) to form negative ions (*4*). It is the negative ions which are drawn to the anode and which initiate the Geiger discharge. The fact that the count is triggered by the slow-moving ions, rather than by free electrons (as in the pure CO_2-filled counter) introduces a time delay which may range up to about 4 milliseconds. Thus the penalty is that after each count of the anticoincidence ring the CO_2 counter channel must be blanked out for several milliseconds, to allow time for the negative ions to reach the anode. This is but a small penalty in a counter of the size and pressure we use, but it does place a "law of diminishing returns" on the extension to higher pressures or larger dimensions, since an increase in either of these factors will increase the delay time, and consequently require a larger fraction of the total time to be taken out by blanking. In our counter, the blanking time amounts to 15 percent of the total counting time.

The advantage of the CO_2-CS_2 counter is that it has a very high tolerance for nonradioactive impurities. In the pure CO_2-filled counter, slight traces of impurities (oxygen in particular) will capture the electrons and result in delayed counts. Since the blanking time is short in these counters, delayed counts are not canceled by the anticoincidence ring and they result in a vitiated counting rate. For example, de Vries (*5*) has found that 1 part of oxygen in 10^{12} in his pure CO_2 proportional counter will cause a spurious counting rate. In contrast, in the CO_2-CS_2 counter a moderate amount of impurities (for example, 0.1 percent) has no perceptible effect, because in the normal operation all of the electrons become attached, and the circuit is designed to allow for the consequent delay time. Consequently, the chemical preparation of the samples is somewhat simpler and the risk of errors resulting from impurities is practically eliminated.

A word should be said about the 3 centimeters of H_2 which is mixed with the sample. This, for reasons which are not understood, lowers the voltage threshold by about 500 volts, lengthens the plateau, and improves the constancy of the counting rate over long periods of time.

The circuit is such that the quench pulse applied to the grid of the CO_2 counter is triggered by the firing of either the anticoincidence ring or the CO_2 counter itself. The quench pulse lasts for about 9 milliseconds. Thus, when a cosmic ray particle passes through both the anticoincidence ring and the CO_2 counter, the latter is made insensitive by the quench pulse *before* it has a chance to fire. This is true because of the inherent lag in the arrival of the negative ions at the anode of the CO_2 counter, as described in the preceding paragraph. Of course, particles which go only through the anticoincidence ring trigger the CO_2 counter also. Thus the CO_2 counter does not, in this arrangement, fire at all when cosmic ray particles pass through it. The quench is of great enough duration to assure the complete clearing of the negative ions formed by the passage of the particle. No further blanking is used. When the CO_2 counter is fired by a C^{14} disintegration the pulse length again constitutes the blanking time.

An important characteristic of the quench circuit used on the CO_2 counter is that the quench pulse does not end until an interval of 9 milliseconds has elapsed in which no ionizing particle has passed through the anticoincidence ring. This takes care of the occasional situations in which cosmic ray particles follow one another within 9 milliseconds or less. For example, if a cosmic ray particle passes through, starting the quench, and another follows 7 milliseconds later, the quench pulse will last 16 milliseconds, allowing the full 9-millisecond clearing time for the CO_2 counter after the passage of the last particle. The 9 milliseconds allowed for the clearing of the ions is actually about twice the maximum time required for a negative ion to be drawn to the anode, so we have an ample safety factor. The time lost because of blanking has been measured under these conditions and found to be, as already noted, 15 percent of the total time. An ordinary Rossi type anticoincidence circuit is connected to the CO_2 quench and the anticoincidence quench, and effects the registering of only those counts in which the C^{14} counter quench fires unaccompanied by the firing of the anticoincidence ring.

Some figures on the performance of the counter will be of interest. The total counting rate of the anticoincidence ring is 800 per minute. The rate at which cosmic ray particles pass through the CO_2 counter is 220 per minute. Two complete counter systems are in operation. Until the summer of 1957 the two counters were housed in individual iron shields of about 10-inch wall thickness. The counting rates in these shields were, with anticoincidence cancellation, 6.5 per minute for dead carbon and 14.5 per minute for modern carbon. A new shield was then built, having a single cavity which housed both counters, and the result was an increase of about 1 count per minute in both modern and background rates. This shield is in use at present but a modification which we hope will restore the background to the previous value will be made in the near future.

Performance records have now been accumulated for over four years, and they show that, except for occasional aberrations due to the failure of specific components such as tubes, anticoincidence counters, and so forth, the constancy of the counting rates has been that expected on the basis of statistics. There have been some slow variations over times of many weeks, of the order of a half a count per minute, due presumably to changes in the level of local radioactivity. Transient effects lasting a day or two have been seen, due to atomic bomb fallout, and once (22 Jan. 1956) a large increase due to solar activity was seen. Such effects as the latter are easy to recognize as external, because they follow the same pattern on the two independent counters.

The foregoing description has been rather general, and has not given any circuit or construction data. Such detailed information can be made available, however, to anyone seriously interested.

References and Notes

1. This work was supported by the Michigan Memorial-Phoenix Project.
2. H. R. Crane and J. B. Griffin, *Science* 127, 1098 (1958).
3. Editorial in the 2 August 1957 issue of *Science* [126, 189 (1957)]. The editors of *Science* announced that, because of the increasing volume of the C^{14} date lists, their publication as articles in *Science* would have to be discontinued, and some other means of distribution substituted. We wish to say that *Science* has rendered a tremendously valuable service in carrying essentially the full publication load for the first decade of C^{14} work.
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Table 1. Radiocarbon dates.

Description	Sample No.	Age (yr)
I. *Upper Mississippi Valley and Great Lakes*		
George Reserve Lake, Livingston County, Mich. Collected and submitted by Stanley A. Cain, University of Michigan.		
Lake bottom muck from a depth of 20 ft.	M-220	4550 ± 500
Lake bottom muck from a depth of 25 to 26 ft.	M-221	5970 ± 900
Fort Dodge, Webster County, Iowa. Two miles west and one mile north of town, along north slope of major stream valley, well within present (1951) Mankato area. The exposure had the following composition: 0 to 3 ft, friable till, presumably Mankato, leached to a depth of 2 ft; 3 to 3½ ft, mixed sands and gravels, calcareous; 3½ to 4 ft, unoxidized calcareous till; 4 to 6 ft, oxidized calcareous sand and gravel; 6 to 9 ft, unoxidized calcareous fine sandy loam with wood encountered in abundance at 7-ft depth; 9 ft +, unoxidized calcareous till. Collected and submitted by Wayne H. Scholtes, Iowa State College.		
Wood sample from 7-ft depth in east part of section.	M-226	> 20,000
Wood sample from 7-ft depth in west part of section.	M-227	> 20,000
East Steubenville shell heap (46 Br 31), Brooks County, W.Va. Fresh-water mussel shells from this Upper Ohio Valley Archaic occupation. Collected and submitted by W. J. Mayer-Oakes, University of Toronto.	M-229	4220 ± 500
Weaver Site, Fulton County, Ill. Fresh-water mussel shell from a house site of the Hopewell culture. The pottery is identified by Wray as 90 percent Hummel Stamped and 2 percent Classic Hopewell. Collected and submitted by Donald Wray, Champaign, Ill.	M-256	2300 ± 250
Beaver County, Pa. Charcoal from Site 36 Mv 29. The sample should date the end of the manufacture of Half-Moon Cord Marked. It was found in a fire pit in the next to the highest level in the site. Collected and submitted by W. J. Mayer-Oakes.	M-345	2130 ± 200
Bedford mound group, Pike County, Ill. Excavated by Gregory Perino for Thomas Gilcrease. Specimens submitted by Dan Morse, Peoria, Illinois.		
Charcoal from crematory basin between mounds Pk°10 and Pk°11. A Hopewell site.	M-443	1930 ± 250
Charcoal from ceremonial log structure under crematory basin between mounds Pk°10 and Pk°11.	M-444	1940 ± 250
Charcoal of grass or mat under burial 19 in mound Pk°4. There were no burial goods with this inhumation, but the mound is Illinois Hopewell.	M-445	1720 ± 250
Wakenda Village site (23CA1), Carroll County, Mo. Collected by F. A. Winfrey, DeWitt, Mo. and submitted by Carl H. Chapman, University of Missouri.		
Charcoal from pits on east side of road with Hopewell pottery and other artifacts. Original sample I.	M-448	1820 ± 250
Charcoal from west of highway where late pottery is predominant. Original sample III (1).	M-450	720 ± 200
Renner Village site (23PL1) Platte County, Mo. Charcoal samples from four different pits in the same excavation trench. Original number 2. This is a Hopewellian village site. Collected by J. M. Shippee and submitted by Carl H. Chapman.	M-454	1270 ± 250
Chrisman site, Pike County, Ill. Mussel shell from an Archaic site which is largely a clam shell deposit with some chipped stone points, slate ornaments, and short three-quarter grooved axes. M. M. Leighton has suggested a geological date of about 3000 yr ago. Collected and submitted by J. C. McGregor, University of Illinois.	M-485	6490 ± 300
Spring Creek site, Muskegon County, Mich. Charcoal from this Late Woodland complex at a "pure" site which suggests that it is relatively early within Late Woodland. The estimated date was about A.D. 900. Collected by Edward Gillis and George Davis, Grand Rapids, Mich., and submitted by James B. Griffin, University of Michigan.	M-512	990 ± 150
Toepfner mound, Columbus, Ohio. Charcoal samples from five different features in this Adena mound. Two other samples from this site have been dated at the Chicago laboratory. Sample C-923, on charred logs from feature II, gave a date of 2377 ± 150 yr, and C-924, on charcoal from feature VII, gave a date of 2780 ± 410 yr (*6*, p. 104). Collected and submitted by Raymond S. Baby.		
From log tomb, feature 2, 7.5 ft above floor of mound.	M-517	2300 ± 200
From log tomb, feature 3.	M-518	2280 ± 200
From log tomb, feature 4.	M-519	2200 ± 200
From log tomb, feature 5.	M-520	2350 ± 200
From charred log, feature 9.	M-521	2410 ± 200
Crable site, Fulton County, Ill. Mussel shell from pit 1 in a Spoon River focus, Middle Mississippi site. Collected and submitted by Dan Morse.	M-556	1150 ± 200
Wilson mound (Wh-6) White County, Ill. Charcoal from the central tomb. Field catalog No. Wh 6-150. This Wabash Valley Hopewell site has been dated (C-684) at 723 ± 180 and 2086 ± 160 yr (*6*, p. 98). Collected by M. L. Fowler and submitted by Thorne Deuel, Illinois State Museum.	M-559	2000 ± 200
Rutherford mound site (Hn252), Hardin County, Ill. Charcoal sample from the floor of the mound in square 25R10. This is regarded as a late Hopewell mound. Collected by M. L. Fowler and submitted by Thorne Deuel.	M-560	1525 ± 200
Wagner Merk mound in Sayler Park area of West Cincinnati, Hamilton County, Ohio. Charcoal from a log tomb about the middle of this Adena mound. Excavated by James Keller and submitted by Ralph Dury, Cincinnati Natural History Museum.	M-570	1860 ± 200
Rocky Fork Lake site, Highland County, Ohio. Charcoal from a charred log around the top edge and the charred bark lining of a rectangular subfloor burial pit beneath the south-central part of the mound. A cremated burial was deposited at the bottom of the feature. This mound had at	M-650	1890 ± 200

Description	Sample No.	Age (yr)
some earlier date been disturbed by unknown diggers. Attributed to late Hopewellian occupation. Collected and submitted by Raymond S. Baby.		
Riverside Cemetery, Menominee County, Mich. Bone fragments, probably both dog and human. The specimens were coated with red ochre and were in feature 6. This is an Old Copper Culture cemetery. Collected and submitted by A. C. Spaulding, University of Michigan.	M-658	3040 ± 300
Stone County, Mo., Site 23SN137. Charcoal from a fireplace associated with pottery fragments that are grit-tempered and decorated with punch and boss and stamped designs. Submitted by Carl H. Chapman.	M-696	1230 ± 200
Jakie shelter (23BY388), Barry County, Mo. Charcoal from Square 75L7, level 4, original No. MU-7. Submitted by Carl H. Chapman.	M-701	2840 ± 250
II. *Mexico and Central America*		
Frightful Cave (CM68), Coahuila, Mexico. The site is 15 mi southeast of Cuatro Cienegas. Collected and submitted by W. W. Taylor, Jr., Mexico City.		
Wild legume pods woven into "rosettes." From the top level of the deposits.	M-186	3230 ± 350
"Agave scuffers" which are loosely and roughly made Agave sandals. From the bottom level of the deposit.	M-187	8080 ± 450
Human feces from the middle level of the cave deposit.	M-189	6170 ± 300
Warp fiber sandals from the top level of the deposit.	M-190	1770 ± 250
San Rafael de Coronado site near San Jose, Costa Rica. Charred plant material from within a pottery vessel. Collected by Jorge A. Lines and submitted by Alex D. Krieger, Riverside (California) Municipal Museum.	M-364	< 250
Schroeder site Durango, Mexico. Charcoal from 75 cm below step 2 of the rectangular unit of structure 12, and above floor 2. Excavated by Augustin Delgado. Should predate the Las Joyas phase of the Chalchihuites culture. Submitted by J. C. Kelley, Southern Illinois University.	M-613	1550 ± 250
Tlatilco, Valley of Mexico. Charcoal samples collected by R. F. Heizer, R. J. Squier, B. B. de Piña Chán, and R. Piña Chán. Submitted by R. F. Heizer, University of California (Berkeley).		
Specimens from soil surrounding a burial located approximately in the middle of the Tlatilco brickyard. The burial was accompanied by an offering of obsidian points and pottery of Tlatilco style. The burial was located 3 to 4 ft from the present surface.	M-660	2525 ± 250
Charcoal from inside offering No. 4 accompanying burial No. 193.	M-661	2940 ± 250
Zacatenco, Valley of Mexico. Charcoal from pit 1, 1950, from 2.6- to 3.0-m level. Collected by R. F. Heizer and R. J. Squier; submitted by R. F. Heizer.	M-662	2450 ± 250
Cuicuilco, Valley of Mexico. Charcoal samples collected by R. F. Heizer, René Millon, and R. J. Squier; submitted by R. F. Heizer.		
Specimen collected at Peña Pobre rock quarry, southwest and across highway from the Cuicuilco Pyramid. Sample taken from 20- to 23-in. level below bottom of lava flow in dark "midden" soil rich in potsherds. The level from which the sample was taken ranged from 14 to 17 in. below the bottom of the burned earth stratum underlying the lava at this point.	M-663	2040 ± 200
Specimen taken from a point 20 ft southeast of sample M-663 and in identical stratigraphic position.	M-664	1430 ± 200
Tlapacoya, near Ixtapaluca, Chalco, state of Mexico. Charcoal from tomb No. 2, mound 1. Sample should date the first stage of construction of the pyramid, which is believed to have been carried out at the end of the upper phase of the Preclassic occupation at this site. Collected by Beatriz Barba de Piña Chán, Mexico City, and submitted by R. F. Heizer.	M-665	2600 ± 250
III. *Lower Mississippi Valley*		
Harlan site, Cherokee County, Okla. A site of the Gibson aspect. Collected and submitted by Robert E. Bell, University of Oklahoma.		
Charcoal from unit 4, level 4, square S2L5, excavated 1 Aug. 1949. Specimen is from unit 4 of the Harlan site. The mound contained three superimposed house structures; this specimen represents charcoal from one of the houses. Original No. 11.	M-64	1280 ± 300
Charcoal from test area 4, house number 3, taken from squares N1R2, N2R2, and N3R2, 13 July 1950.	M-65	720 ± 200
Cedar Creek, near Carnegie, Caddo County, Okla. Collected and submitted by Robert E. Bell.		
Wood from a log in fill of the second deposition phase of Cedar Creek, 10 ft from the top of the high terrace.	M-210	< 200
Charcoal and ash from a hearth in the second deposition phase of Cedar Creek.	M-211	> 300
Little Woods area (Or 11) Orleans Parish, La. Rangia shells from 3½ ft below water level on the periphery of the deposit of this Tchefuncte site. Collected and submitted by W. G. McIntire, Louisiana State University.	M-218	1570 ± 250
Big Oak Island (OR6), Orleans Parish, La. Rangia shells associated with Tchefuncte pottery at a depth of 4½ ft below the mound surface in the south bank of test trench No. 8. Collected and submitted by W. G. McIntire.	M-243	2220 ± 200
O'Bryan Ridge (23 mi 20) Mississippi County, Mo. Charcoal from a refuse pit in excavation unit 3, pit 1, level 6, 30 to 36 in. deep. Pottery from this level is Mulberry Creek Cord Marked, 63 percent; Baytown Plain, 28 percent; Withers Fabric Impressed 5 percent; and unidentified cord-impressed, 4 percent. This complex is part of the Burkett focus (or phase). Collected by Stephen Williams for the University of Michigan and submitted by J. B. Griffin.	M-438	2140 ± 250
IV. *Eastern United States*		
Steppel site, Morris County, N.J. Charred grasses found in connection with a burial and grave goods at a Late Woodland site. Submitted by R. J. Mason for the New Jersey State Museum.	M-593	200 ± 200

Description	Sample No.	Age (yr)
V. *Plains*		
Site 25 HK 13, Hitchcock County, Neb. Fresh-water shell from a Woodland site related to the Keith focus. Collected and submitted by Marvin F. Kivett, Nebraska State Historical Society.	M-181	2080 ± 250
Site 25 Vyl, Valley County, Neb. Fresh-water shell from a Woodland site of the Valley focus. Collected and submitted by Marvin F. Kivett. The date is regarded by the collector as much too early.	M-182	3830 ± 300
VI. *Western United States*		
Sorrento site, (W-316) San Diego County, Calif. Miscellaneous local marine shells from the 18- to 24-in. level. Dates a phase of the La Jolla culture. Collected and submitted by Carr Tuthill, Scripps Institution of Oceanography.	M-114	6950 ± 350
Site A:10:1, Moffat County, Colo. Uncharred corn cobs of predominantly Mexican pyramidal type (according to V. H. Jones) associated with beehive-shaped masonry granaries. No Pueblo artifacts, pottery, or architecture is in association. Some of the stone material resembles Shoshonean types. Collected for the University of Denver and submitted by G. R. Wenger, U.S. National Park Service.	M-285	400 ± 150
Grants, New Mexico, area. Charcoal from an old dune site (site No. 1) of the San Jose complex. From a hearth associated with uncultivated *Amaranth* seeds. This is a local variant of the Pinto-Gypsum-Chiricahua hunting-gathering complex. Collected by G. A. Agogino and J. Hester for the University of New Mexico and submitted by G. A. Agogino, Syracuse University.	M-346	6880 ± 400
Wakemap site (45KL26), Klickitat County, Wash. Collected by University of Washington excavators and submitted by Douglas Osborne.		
Charcoal from stratum B, test trench 2. Original number 22.	M-423	1050 ± 200
Charcoal from stratum A, test trench 2. Original number 26.	M-424	620 ± 200
Charcoal from stratum B, test trench 2. Original number 31.	M-425	615 ± 200
Charcoal from stratum A, test trench 3. Original number 39.	M-426	890 ± 200
Charcoal from stratum A, test trench 3. Original number 41.	M-427	1080 ± 200
Little Harbor site, Santa Catalina Island, Calif. Charcoal fragments from bottom of shell midden (pit 60, 24-in. depth, resting on sterile clay beneath midden). Charcoal was under inverted *Haliotis* shells which protected it from moisture and penetration by plant rootlets. The culture is pre-Canalino and represents one of the Intermediate cultures of southern California. Collected and submitted by C. W. Meighan, University of California (Los Angeles).	M-434	3880 ± 250
Jemez Cave, Jemez Canyon, Sandoval County, N.M. Corn cobs of early type believed by V. H. Jones to be of generalized Bat Cave character. From square IX, levels 7 to 9. Collected by P. Reiter and submitted by V. H. Jones, University of Michigan.	M-466	2440 ± 250
Lake LeConte, Riverside County, Calif. Charcoal from an unnamed site along the eastern beachline close to siphon 27 of the Coachella Main Canal, 22 to 30 in. deep in a clay deposit behind an old longshore gravel bar, at the lowest fire level. In addition to the charcoal, this layer contained fireplace ash, stone, and fish bone. The fish bone is regarded as midden material indicative of fresh-water lake conditions. The object of the dating was to determine the age of this lake stage and of the occupation. Collected by B. E. McCown and party, San Diego, Calif., and submitted by Carl L. Hubbs, Scripps Institution of Oceanography.	M-596	450 ± 200
Lake LeConte, Imperial County, Calif. Charcoal from the lower level of the Split Mountain dune site at approximately lat. 33°2.2′ N., long. 116°1.9′ W. The lower occupation level, only a few inches thick, is separated by about 2 ft from the surface midden. It contains only a trace of pottery, whereas the surface abounds in potsherds. The few projectile points resemble Playa points and contrast sharply with the more modern types on the surface. Fish bone indicative of fresh-water lake conditions is included. This is taken to represent the lake stage preceding the last relatively recent and much better known stage. Collected by B. E. McCown and party; submitted by Carl L. Hubbs.	M-597	130^{+200}_{-130}
Lake LeConte, Imperial County, Calif. An unnamed site between Kane Springs and Truckhaven at approximately lat. 33°11.8′ N., long, 115°56.3′ W. Charcoal from fire pits about stone house rings in the ancient beach line. This occupation appears to have been associated with the last filling of Lake LeConte. The charcoal from this site was selected to date the relatively recent stage of Lake LeConte, and of the accompanying fish fauna (of ascertained species) and human occupation (with much pottery, late projectile points, and so forth). Collected by Carl L. and Laura C. Hubbs and submitted by Carl L. Hubbs.	M-598	120^{+200}_{-120}
Santa Rosa Island, Calif. Charcoal from the west side of Garonon Cañon about 100 ft from its mouth, 2.7 mi (in straight line) from west end of island. This specimen is from a definite, rather large, almost solid mass about seven-tenths of the way up steep canyon side about 50 to 60 ft high. The site is near the middle of the Pleistocene beds from which many dwarf mammoth remains have been taken, of which some were found partly burned in what appear to be hearths. The only traces of artifacts have been crude flaked stones of disputed human origin. The sample is well below the level of middens that have been dated 6500 and 7000 yr before the present. Collected and submitted by Carl L. Hubbs.	M-599	16,700 ± 1500
Blossom site (4-SJo-68), San Joaquin County, Calif. Collected and submitted by Robert F. Heizer.		
Charcoal sample No. 1 is a composite sample from various depths in a midden of the Windmiller facies. Early Horizon with an estimated date of about 2000 B.C. Previous samples from this single phase site (C-440 and C-522 combined) were dated	M-645	4100 ± 250

Description	Sample No.	Age (yr)
4052 ± 160 (*6*, p. 112). The soil is highly calcareous.		
Calcined bone, sample 3, in cremation pit 3, at a depth of 50 in.	M-647	4350 ± 250
Johnson site (4-Sac-6) near Sacramento, Calif. Charcoal from basketry and wood of grave pit burning of burial 67. The burial represents the late phase 1 period of the Late Horizon culture, and should date later than 1229 ± 200 yr (C-689), already obtained for a middle phase 1 burial. Collected and submitted by Robert F. Heizer.	M-648	620 ± 200
Humboldt Lake bed site (26-Ch-15), Churchill County, Nev. Charcoal and charred basketry from cremation and surface pit. This is an open-site manifestation of the Lovelock culture for which there is a known radiocarbon range from about 3200 to 1700 yr before the present. Lovelock culture persisted until, or nearly until, the opening of the historic period in western Nevada. Collected and submitted by Robert E. Heizer.	M-649	2690 ± 250
VII. *Far East and Pacific*		
Yoshiga shell mound, Aichi Prefecture, Honshu, Japan. Attributed to the later Jomon period. Collected and submitted by Eiji Nakayama, Catholic University of Nagoya.		
Marine shell associated with burial 1 in trench 1a.	M-165	2800 ± 600
Marine shell from lowest stratum of section H, trench 3.	M-174	2870 ± 250
Kishima, off Ushimado Peninsula in Okugun, Okayama, Japan. Shell from the Initial Jomon period, equivalent approximately to the Tado component of the Kanto area. Collected by Yashimasa Kamaki, Kurashiki Archaeological Museum, and submitted by Richard K. Beardsley, University of Michigan.	M-237	8400 ± 350
Kori shell mound, Okayama Prefecture, Japan. Shell from deposits of the Middle Yayoi (Yayoi II) period. Collected by Yashimasa Kamaki and submitted by Richard K. Beardsley.	M-239	2350 ± 200
Rupkund site, Nepal. Human skeletal material collected by D. N. Majumdar, Lucknow University, and submitted by him. According to H. R. Crane, it is probable the true date is toward the upper limit of the given range.	M-652	650 ± 150
South Pacific, various islands. Specimens collected by Thor Heyerdahl and party and submitted by him through William Mulloy, University of Wyoming.		
Charcoal from Tipona Meae, Hive Oa Island. Marquesas No. 16. Original number Journ X352.	M-704	470 ± 150
Charcoal from hill terraces at Vaiuru, Raivaure. Found in refuse heap at northern end of construction A, terrace 1. Original number Journ X350.	M-705	180^{+200}_{-180}
Charcoal from Tipona Meae, Hiva Oa Island, Marquesas No. 1. From trench through terrace in front of tiki. Horizontal, 5.5 to 6 mi; vertical, 90 to 95 cm. Bones of pig found at the same depth. Original number Journ X351.	M-706	460 ± 200
Charcoal from Rapa Island pit in house terrace at head of bay.	M-707	620 ± 200
Charcoal from site E-11, Orongo, Easter Island. From level 1, horizon A. Strat. trench 1. Original No. 3.	M-708	100^{+200}_{-100}
Charcoal from platform surface back of Ohu No. 1, Vinafru, Easter Island. Level of second occupation. Original No. 4.	M-709	120^{+200}_{-120}
Charcoal sample No. 6 from beneath dirt wall surrounding plaza of Ohu No. 2, Vinafru, Easter Island.	M-710	1100 ± 200
Charcoal from Rapa Iti Island, Morongo Uta Fort, section 2, terrace 5, room 1, floor level surrounding fireplace.	M-712	310 ± 200
Charcoal from Rapa Iti Island, Morongo Uta Fort, section 1, terrace 2, room 4. Recovered from floor level.	M-713	210 ± 200
VIII. *Southeastern United States*		
Wilbanks farm site (Ck-5), Cherokee County, Ga. Charcoal from burned log sealed under fill of earth lodge walls. Earth lodge was built in Etowah III period after debris of earlier occupations had been removed from the building site. Etowah III is the peak period of Southern Cult activity and mound usage both at CK-5 and at the Etowah site. Collected and submitted by W. H. Sears, Florida State Museum.	M-112	340 ± 150
Cotten site (V-2), Volusia County, Fla. Fasciolaria gigantea shell from square 15R1, level 16, associated with Orange Plain and Orange Incised pottery exclusively. Collected and submitted by John W. Griffiin, St. Augustine Historical Society.	M-215	3020 ± 200
Dulany site, Chatham County, Ga. Oyster shell 18 in. from the base of the midden in association with a plain fiber tempered pottery complex which closely resembles that at Sapelo Island, Ga., which was dated (M-39) at 3700 ± 250 yr. Collected and submitted by A. J. Waring, Jr., Savannah, Ga.	M-236	3770 ± 200
Refuge site, Jasper County, S.C. Shell from a "clambake" at a depth of 36 in. in an 8-ft shell midden. The pottery associated is the Refuge complex which is the earliest Woodland pottery at the mouth of the Savannah River. Estimated date 500 to 1000 B.C. Collected and submitted by A. J. Waring, Jr.	M-267	2920 ± 200
Camp Creek site (1GN1), Greene County, Tenn. Charcoal from the bottom level (c) of the site, about 3 ft below the plow line, and about 1 ft above the base of the cultural zone. The site has 85 percent fabric impressed pottery. Collected by members of the Tennessee Archaeological Society and submitted by T. M. N. Lewis, University of Tennessee.	M-516	2050 ± 250
Roanoke Rapids site (Hx v7), Halifax County, N.C. This is a stratified site running from Archaic to almost historic times. Collected and submitted for the University of North Carolina by Joffre Coe.		
Charcoal associated with Halifax-Archaic type points. Original numbers 619 eb 178 from 63 to 68 in. and 619 eb 179 from 70 to 76 in.	M-522	4280 ± 350
Charcoal associated with Halifax-Archaic type points. From fireplaces 1, 2, and 3, from 54 to 62 in. deep.	M-523	5440 ± 350
Charcoal associated Savannah River-Archaic type points. From fireplaces 1 and 6, from 38 to 49 in. deep.	M-524	3900 ± 250
Charcoal associated with the Clements-Uwharrie focus of the Piedmont area.	M-525	370 ± 200

Description	Sample No.	Age (yr)
Estimated by Coe to date about A.D. 1500 and to just precede the Clarksville focus.		
Charcoal associated with cord-marked and fabric-marked Woodland pottery from features 20, 55, 102, and 105. Unfortunately, feature 55 belongs to the Clements level and this date is probably somewhat too recent.	M-526	1040 ± 200
Charcoal from the Clarksville focus, feature 148, which is the last prehistoric cultural material in the area.	M-527	215 ± 200
Bland Cave, Harlan County, Ky. Charcoal from station 11, in entrance to cave. Associated with a late Archaic complex. Excavated by Edward Ray, Roscommon County, Mich., and Roger Leatherman, University of Michigan; Submitted by R. Leatherman.	M-561	3030 ± 250

E. O. Lawrence—Physicist, Engineer, Statesman of Science

Ernest Orlando Lawrence's scientific accomplishments and influence on science are almost unique in this generation and rank among the most outstanding in history. His cyclotron is to nuclear science what Galileo's telescope was to astronomy. A foremost symbol of the rise of indigenous American science in the 20th century, Lawrence, perhaps more than any other man, brought engineering to the laboratory, to the great benefit of scientific progress. He originated a new pattern of research, of the group type and on the grand scale, which has been emulated the world over. Rarely, if ever, has any person given so many others, in such a small span of years, the opportunity to make careers for themselves in science. Lawrence was a leader in bringing the daring of science to technology, in wedding science to the general welfare, and in integrating science into national policy.

Lawrence was born between two pioneering eras, on 8 August 1901, in the small town of Canton, South Dakota, on the Big Sioux River—the second-generation product of educated Norwegian immigrants. When Lawrence was born, the echoes of the taming of the Great Plains had hardly died away. From this pioneering heritage and through some biogenetic conjugation still beyond the grasp of science, Lawrence derived qualities that uniquely fitted him for grand explorations in the nascent science of the 20th century. Lawrence was a big, robust son of his Norwegian forebears, with virtually unlimited energy, which he expended without reserve in long hours in the laboratory, in consultation with colleagues, in planning new projects, and in the taxing airplane trips and conferences important to national policy. He was characterized by boldness, enterprise, innate modesty, and an open, friendly spirit. His *joie de vivre* and his buoyant optimism spread to everyone around him and accounted for the attainment of many an "impossible" objective.

Lawrence attended the public schools of Canton and Pierre, South Dakota. He began college work at St. Olaf's College, in Northfield, Minnesota, and went on to the University of South Dakota for his B.S. degree. Inspired by South Dakota's Dean, Lewis E. Akeley, he entered the University of Minnesota to study physics and obtained the M.A. For two years he studied at the University of Chicago, transferring to Yale, where he received the Ph.D. in 1925. After three more years at Yale, as a National Research Fellow and as an assistant professor of physics, Lawrence (already a promising young physicist) came to the University of California in 1928 as an associate professor. In 1930, at the age of 29, he became the youngest full professor on the Berkeley faculty.

Lawrence's reputation of the late 1920's was solidly based. His doctor's thesis was in photoelectricity. Later, he made the most precise determination, to that time, of the ionization potential of the mercury atom. With J. W. Beams he devised a method of obtaining time intervals as small as three billionths of a second, and he applied this technique to study the early stages of electric spark discharge. He originated a new and more precise method for measuring e/m which was perfected by F. G. Dunnington.

In 1929 young Lawrence, who for some time had been contemplating the problem of accelerating ions, chanced, while scanning the literature, upon a sketch in a German publication. He forthwith formulated, within minutes, the principles of the cyclotron and the linear accelerator and so set himself upon a course that was to influence, fundamentally, scientific research and human events.

Between the brilliant, simple concept and operating machines lay engineering barriers not previously encountered. Lawrence's willingness to tackle new engineering problems and his success in solving them, as he reached for successively new energy ranges, was a departure in scientific research that is an important part of his contribution. The hard road he chose was recognized when W. D. Coolidge, presenting the National Academy of Science's valued Comstock Prize in 1937, said in part, "Dr. Lawrence envisioned a radically different course . . . [which] called for boldness and faith and persistence to a degree rarely matched." By 1936 the scale of research and supporting engineering development was so large that the Radiation Laboratory was created at the University of California to satisfy the administrative requirements. The prototype of the big laboratory had been born.

The range of contributions that have flowed from Lawrence's invention and his leadership are evident from some important examples: world leadership, for more than a quarter of a century, in the development and use of high-energy accelerators; the discovery of hundreds of radioactive isotopes, such as carbon-14,

iodine-131, tritium, and uranium-233; the discovery of 12 (two with the collaboration of other laboratories) out of 14 of the synthetic elements, including plutonium, the atomic energy fuel; the first laboratory production and study of mesons; the discovery of antiparticles; pioneering tracer experiments with radioactive isotopes; the initiation of treatment of human disease with radioactive isotopes and with heavy particles from cyclotrons.

A fundamental factor in such achievements was Lawrence's character and energy. He had the vision to glimpse the limitless nature of the horizon and the generosity to make room for others. His personal credo was, "There is enough research for all of us to do." He interceded, with his rare persuasiveness, to create new facilities for worthy projects. He rejoiced as jubilantly in the success of others as in his own. As a result, the careers of many scientists, my own included, are founded on his large contributions and his generous nature. Indeed, so great was the opportunity he created that he was influential in the training of a significant portion of the present corps of nuclear scientists.

From the beginning, the Radiation Laboratory attracted scientists from all over the world, and it has been an international center of nuclear and biological research. When radioisotopes were first being produced in quantities large enough for tracer studies, Lawrence characteristically shipped part of the supply of radiophosphorus to Belgium for the use of G. Hevesy, who had initiated tracer studies with lead in the 1920's. Thereafter, radioisotopes were shipped to many individuals and laboratories abroad.

Lawrence's catholic interests made him a dedicated disciple of the new concept of interdisciplinary collaboration, and nowhere did such research flourish more than in his laboratory. In the early 1930's he personally initiated and carried through the construction, at the University of California Medical Center in San Francisco, of one of the earliest million-volt x-ray machines—the tube suggested by David Sloan. He strongly encouraged physicists to work with biologists. He set up his own radioisotope distribution system, supplying isotopes to hundreds of doctors and numerous institutions in the prewar period.

Ernest Orlando Lawrence

Lawrence helped bring big science to government. His contributions were crucial to the success of the Manhattan Project. He was instrumental in organizing the Los Alamos Scientific Laboratory. In the postwar period Lawrence continued to influence national policy decisions, advocating accelerated development of thermonuclear weapons and insisting that America maintain her nuclear strength in the absence of adequate safeguards. The Livermore Laboratory is one consequence of this view.

Lawrence's uncompromising conviction that free institutions must be protected, through strength, against tyrannies was accompanied by an optimistic hope that peace could be made permanent. His trip to Geneva last July to take part in developing an agreement on means for detecting nuclear weapon tests was one of many expressions of this optimism and of his deep devotion to duty. The pressures of the deliberations apparently precipitated Lawrence's final illness, forced him to leave Geneva in the midst of negotiations, and brought his career to a premature end in Palo Alto, California, on 27 August 1958. Literally, Ernest Lawrence gave his life for peace.

Lawrence was honored in full measure. The awards to him included the Nobel Prize for 1939, the Hughes Medal of the Royal Society, the Medal for Merit, the Faraday Medal, the American Cancer Society Medal, the Enrico Fermi Award, and the first Sylvanus Thayer Award. He was a member of such learned societies as the National Academy of Sciences and the American Philosophical Society and recipient of many honorary degrees and memberships in foreign societies.

To his large and handsome family, Lawrence gave devotion and a full measure of his cheerful spirit—to Mary Blumer, his wife, and to his children John Eric, Margaret Bradley, Mary Kimberly, Robert Don, Barbara Hundale, and Susan. With his brother, John Hundale, who came to Berkeley in 1935 to pioneer in the use of the products of the cyclotrons, Ernest maintained an affectionate camaraderie.

In speaking of Lawrence's own work, the research that radiated from it, and his influence upon his time, one is not merely tempted but, rather, compelled to use the superlative. One effort to assess the work of the man who, throughout his life, remained very much an uncomplicated son of the Great Plains was made in the citation of the Research Corporation's Scientific Award of 1937, which read in part: "Ernest Orlando Lawrence has made accessible a new world within the nucleus . . . is a vigorous and inspired pioneer in its exploration . . . [has opened] vast new areas of knowledge. . . . His achievements stand with the great work of the ages."

GLENN T. SEABORG
University of California, Berkeley

News of Science

Widening the Nuclear Research Resources of Universities in Britain

Britain's National Institute for Research in Nuclear Science was set up in 1957 and the first major piece of equipment, a 7-Bev proton synchrotron, is now being constructed. The aim of the new institute is to strengthen the resources of university research departments, not to replace them by a central laboratory. The universities will be able to use the laboratories of the National Institute as out-stations. Several high-energy accelerators for use in fundamental research have been constructed in Britain since the war, at the universities of Birmingham, Liverpool, Glasgow, and Oxford, and at the Atomic Energy Research Establishment, Harwell. All are working well and are the centers of active research groups, but they must be reinforced by accelerators for higher energy if a balanced program is to be pursued in the future.

Effective Training Ground

The type of accelerator needed for this purpose would not only be costly in money and manpower for construction, but would involve large operating, maintenance, and development staffs beyond normal university resources. Active research in very high energy is necessary not so much for national prestige as for the well-being of the universities as a source of young scientists. Moreover, an accelerator project is an exceptionally effective technological training ground and benefits the industrial firms which contribute to its construction as well as the people who form the design and development team.

It was for these reasons that the National Institute was founded, and although universities will still need to extend and develop their nuclear research facilities in their own laboratories, they will be able to concentrate upon those programs which can be supported there without overtaxing their present and future resources.

The membership of the institute's Governing Board includes senior representatives of Britain's universities, the Royal Society, the University Grants Committee, the Department of Scientific and Industrial Research, and the United Kingdom Atomic Energy Authority; the chairman is Lord Bridges.

Identity of Interest

The Atomic Energy Authority plays a special part, since it already possesses the scientific, technical, and service resources necessary for the support of major accelerator projects. Moreover, the Authority has always devoted a proportion of its activities to pure research in nuclear science as an essential ancillary to the atomic energy program. For example, the Atomic Energy Research Establishment at Harwell has its own high-energy research program, at present centered upon the use of the 110-inch synchrocyclotron and the study of design problems of large accelerators.

Thus the Authority has the means to produce the equipment required by the National Institute, and also has an identity of interest with the universities in making use of it. The results of the institute's work will be published in open literature, and no security clearance procedure will be applied to university staff working at or visiting its laboratories.

The first laboratory of the institute, named the Rutherford High Energy Laboratory in commemoration of Lord Rutherford's work in pioneering nuclear physics, is being built alongside the Atomic Energy Research Establishment at Harwell, but outside the security fence. The design and construction of the first accelerator, a 7-Bev proton synchrotron, is being handled by the Atomic Energy Authority at the request of the Governing Board of the institute.

Determining Factor

The choice of 7 Bev was determined by the fact that nearly all the known phenomena of interest can be observed at this energy. The machine is designed to produce a high intensity (about 10^{12} protons per second), and has been chosen to be complementary to the 25-Bev CERN (Centre Européen de Recherche Nucléaire) accelerator being built in Geneva; the CERN accelerator will give a lower intensity at a higher energy, and will be available to British physicists.

The magnet will contain 7000 tons of steel of special magnetic quality, and will be assembled on a ring of about 150 feet diameter in such a way as to leave eight straight, field-free regions between the curved portions. One of the eight straight sections will be used for the radio-frequency accelerating system, another for the injection apparatus, and the remaining six for beam extraction systems, targets for bombardment by the circulating beam, and beam control electrodes.

The steel yoke, containing the bulk of the 7000 tons of steel, is being manufactured by Joseph Sankey and Sons, Ltd., of Bilston, Staffordshire, in some 336 units each weighing about 20 tons. The steel plate is being produced on a continuous strip mill at the Port Talbot works of the Steel Company of Wales. The pole pieces and energizing coils are still being designed at Harwell, together with most of the rest of the accelerator, and contracts have not yet been placed.

A Special Building

The machine proper will be housed in a concrete building about 200 feet in diameter, with about 25 feet of earth and concrete overhead and several times this thickness around the sides. A concrete wall, 28 feet thick, will separate a portion of the magnet ring from adjacent experimental rooms, into which beams of particles will be admitted through channels. The experimental rooms and the accelerator building will be provided with cranes of up to 30 tons capacity to lift the massive particle detection apparatus and components of the machine. Excavation was started on the site in July 1957, and the main building contract was awarded in November 1957 to W. E. Chivers and Sons, Ltd., of Devizes, Wiltshire, England.

The design of accelerators is not straightforward engineering; it also involves research in physics and development work. A large team of physicists and engineers has been assembled on this project at Harwell, and various parts of the machine are now in each of the successive stages, from calculations by theoretical physicists to manufacture in industry. It is hoped that construction will be completed by the end of 1961, but long before that time the institute will be setting up teams of nuclear physicists to prepare apparatus for the initial research program.

T. G. PICKAVANCE, *director*
Rutherford High Energy Laboratory,
National Institute for Research in Nuclear Science,
Harwell, England

More Scientists for Europe

Plans for action by the countries in the Organization for European Economic Co-operation to increase the supply of qualified scientists and engineers have been reviewed by the council of the OEEC. At a meeting in October to discuss the program for the first year, the secretary general, René Sergent, outlined the actions already taken and the activities for the remainder of the first year, which include steps to improve the teaching of science and mathematics, a program for the exchange of senior scientists, and the support of training institutions in highly specialized scientific fields.

The secretary general emphasized that action by the OEEC in the scientific personnel field grew out of the conviction that the economic growth of Western Europe depended in substantial measure on the underlying strength of its science-based industries. This industrial strength is possible only if the countries of Western Europe make full use of their human resources.

Sergent also announced that the policy for the second year will be considered by the council on 15 December. In conjunction with this announcement, the U.S. Government offered to increase its contribution to the program from $500-000 to up to $750,000, to be matched by an equal contribution from the OEEC countries.

The OEEC will in the next year, through a program already developed by the Governing Committee for Scientific and Technical Personnel, take the following steps.

1) Improve the data on the demand and supply of scientists and engineers. Specific proposals for improving forecasting techniques and establishing international comparability of definition and equivalence of professional titles are included in the program. Improve the teaching of science and mathematics at the secondary-school level. OEEC's Office of Scientific and Technical Personnel has already sponsored two international demonstration courses for secondary-school teachers and supervisors at Keele University in Great Britain and at Tutzing in Germany. A third course, principally concerned with the teaching of mathematics, will be held at Sèvres in November. Approximately 122 educators from 18 countries will have participated in these sessions.

3) Increase the flow of senior scientists among training or research institutions in member countries to exchange techniques and strengthen the training institutions. A program of senior visiting fellowships financed from a general fund will be put into action immediately.

4) Support the growth of individual institutions with special competence for giving training in important highly specialized fields; these institutions are to be open to students from any of the member countries. Proposals for the support of training centers of this kind are now being jointly drawn up by several of the member countries that have agreed to collaborate in this scheme.

5) Identify the most effective means of providing opportunity for additional scientific and technical training to those already in industry. A special study of effective techniques now in practice in the member countries will be undertaken to provide information that will make possible more widespread use of these schemes throughout the OEEC community.

6) Conduct an annual review of developments in the training and utilization of scientific and technical personnel in each of the participating countries, thus identifying techniques that might be used in another country, and at the same time showing the areas where international action can be most effective. The first series of these annual reviews will be inaugurated by an examination of the programs of scientific personnel of the United Kingdom, Denmark, and Norway; this will take place in November. The inquiry conducted in these countries, by teams of international specialists, will culminate in a meeting in Paris on 2 and 3 December that is to be attended by senior officials of the countries being examined, an international panel of experts composed of members of the examining teams, and the OEEC Governing Committee. Surveys of the remaining countries are scheduled throughout the year at approximately 6-week intervals.

At the October meeting the secretary-general expressed the hope that the program would continue to have the active interest and support already given it by industrial, labor, educational, and professional scientific and technical groups. In this connection, he noted with satisfaction the resolution adopted recently by the Consultative Assembly of the Council of Europe; this resolution recommended that the Committee of Ministers of the Council of Europe support the Council of the OEEC in its activities in this field.

Scientific Information Conference

The problem of the storage and retrieval of scientific information will be explored by specialists from more than a dozen countries at an International Conference on Scientific Information, to be held at the Mayflower Hotel in Washington, D.C., 16–21 November, under the sponsorship of the National Academy of Sciences–National Research Council, the National Science Foundation, and the American Documentation Institute [for program outline, see *Science* **126**, 464 (29 Aug. 1958)]. Without convenient and rapid access to data from previous research, there can be no real scientific progress. Under ideal circumstances, all such data are first published in full for workers in the immediate field; then abstracted for interdisciplinary dissemination; indexed, codified, microfilmed or otherwise processed for storage; and, finally, retrieved in library search.

During recent years, however, the outpouring of data has all but overwhelmed the small group of abstractors, indexers, and other information specialists. More scientific information is being produced than can effectively be stored and retrieved, and that body of information is said to be doubling every 10 years.

Since the nature and scope of the problem was first examined formally by the Royal Society of London in 1948 and UNESCO in 1949, various solutions have been offered, including many ingenious proposals for the use of mechanical and electronic aids in the preparation of material for storage and retrieval. Some of these methods have already been put to use and will be described at the conference; others, such as mechanical devices for translating and abstracting, are still in the design or conjectural stages.

Although there is some controversy over the most promising solutions to the problem of storage and retrieval, there is little disagreement about its magnitude. At the present time, many investigators find it less expensive to conduct laboratory experiments anew than to search for previously reported data, even though their existence can be taken for granted.

The conference program, which has been 3 years in preparation, will include discussions of the kind of information scientists need, the effectiveness of present-day systems for organizing information, intellectual and mechanical problems encountered in the development of new systems, the search for a general theory, and finally, a consideration of the responsibilities of government, professional societies, universities, and industry in the field of information services.

Two unusual features of the conference reflect painstaking efforts on the part of the organizers to deal directly with the problems under discussion:

1) To make more effective use of conferees' time, none of the 75 papers selected for presentation at the conference will be read during the meeting; instead, full-text preprints of all papers, in 1500-page volumes, have been made available to the discussants in advance

of the meeting. Preprints are also being distributed to all contributors and registered observers.

2) With a thought to future experimentation, the typography of the preprint volume was designed so that the perforated tapes used in its monotype composition might some day be run through a computer system for statistical analysis.

U.N. Atomic Conference Proceedings

The United Nations published on 20 October the first printed volume of the Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy held in Geneva 1–13 September 1958. The volume, entitled *Survey of Raw Material Resources,* is volume 2 of the 33-volume series which will be published in English. The English version of the proceedings will contain all of the 2135 scientific papers that were submitted to the conference by 46 governments and six intergovernmental organizations, as well as the discussions held during the conference and the evening lectures delivered.

It is expected that the remaining 32 volums of the English version will appear before June 1959; some of the volumes are already in the press. To ensure the speedy publication of this large body of scientific material, one of the largest single publishing ventures ever undertaken, the services of printers in Switzerland, France, England, Canada, and the United States have been engaged.

A special scientific editing team has been at work since last April preparing the material for publication and is currently working in Geneva. The size of the task can be judged from the fact that the publishing schedule calls for the publication in volume form within 8 months of approximately 15,000 illustrations and 39,000 manuscript pages.

Abridged editions of the proceedings will be published in French, Spanish, and Russian during roughly the same period and on a similar schedule as the English edition. The abridged versions will contain all papers orally presented at the conference, all papers originally presented in the language of the version concerned, the records of all conference sessions, and a limited number of other especially selected papers. The abridged versions are expected to consist of 12 or 13 volumes. The French and Spanish volumes will be prepared and published in Europe. The Russian edition will be prepared in Moscow.

The United Nations has made special arrangements to inform interested readers in all areas of the availability of these volumes and to facilitate the purchase both of complete sets and individual volumes. Orders for the complete English edition will be filled until 30 November at the special prepublication price of U.S. $435, £155 (sterling), F. 1860 (Swiss) (or the equivalent in local currencies). Orders may be placed with the United Nations, New York or Geneva, or with leading bookstores throughout the world. Payment in local currency may be made in all countries.

Conquest

Man's struggle to master the sea is one of the subjects of the program in the "Conquest Science Series" that will be shown on 16 November over the CBS Television Network, 5:00 to 6:00 P.M., E.S.T. The television report will explore the birth and death of waves and the effort to end erosion. The program on waves is being offered in cooperation with the U.S. Army Corps of Engineers and the U.S. Soil Erosion Board in Washington, D.C.

The "Conquest" presentation will also show a brain operation being performed at Johns Hopkins University by Earl Walker, well-known neurosurgeon. He will be assisted in the report on the brain by Robert B. Livingston and Edward Evarts of the National Institutes of Health, James Olds of the University of Michigan, and Neil Miller of Yale University.

"Conquest" is presented in cooperation with the AAAS and the National Academy of Sciences. It is sponsored by the Monsanto Chemical Company.

News Briefs

Researchers and clinicians from all parts of the country met in Washington on 27 October to lay groundwork for new research on the effects of tranquilizers and other drugs on children. The conference was called by the Psychopharmacology Service Center of the U.S. Public Health Service's National Institute of Mental Health.

* * *

The second issue of the *Index to Plant Chromosome Numbers,* compiled from nearly 300 journals published in 1957, is now ready for distribution. There are approximately 2000 listings of original chromosome counts from the entire plant kingdom and a bibliography of 196 papers from which the listings were taken. Preparation of the *Index* has been supported in part by a grant from the National Science Foundation. The price of each issue is $1. Orders for subscriptions may be sent to: Dr. C. Ritchie Bell, Department of Botany, University of North Carolina, Chapel Hill, N.C.

The first successful rearing in the laboratory of the commercially important blue crab has been reported by John D. Costlow, research associate at the Duke University Marine Laboratory, Beaufort, N.C.

* * *

The Council of the Oak Ridge Institute of Nuclear Studies held its 14th annual meeting in Oak Ridge, Tenn., on 21 October and elected Fisk University as its 37th sponsoring university. James R. Lawson, head of the department of physics at Fisk, was named to represent the university on the ORINS Council, which is composed of one delegate from each sponsoring institution. The council elected as its new chairman Robert T. Lagemann, head of the Vanderbilt University department of physics.

* * *

The Expert Panel on Tick-Borne Diseases of Livestock, formed by the Food and Agriculture Organization of the United Nations and the International Office of Epizootics, will hold its inaugural meeting in London 24–29 November. Discussions on the various tick-borne diseases will include control of the tick-vectors, research methods and techniques for studying the organisms that cause tick fever in cattle, and recent developments in regard to the control of these diseases in the various countries represented.

* * *

The Atomic Energy Commission has announced the start of construction on a pilot plant at its National Reactor Testing Station, Idaho, for calcining high-level radioactive liquid waste products. The $6 million waste calcination facility is designed to reduce high-level liquid radioactive wastes to safer and more storable solids. Laboratory and pilot-plant models have demonstrated that the calcining process will reduce the volume of liquid waste to about one-seventh of its present bulk.

* * *

The Haffkine Institute, Bombay, India, will be celebrating its diamond jubilee, 10–14 January 1959. The celebrations will be inaugurated by the president of the Republic of India. The program will include lectures and seminars on such topics as plague, cholera, rabies, influenza, poliomyelitis, snakes and venoms, and insect resistance to insecticides. These sessions will be on an international level of participation. All scientists are cordially invited to attend.

Grants, Fellowships, and Awards

General. The National Academy of Sciences–National Research Council will again assist the National Science Foundation with its eighth regular predoctoral and postdoctoral fellowship programs.

The NSF plans to award approximately 1000 graduate and 200 postdoctoral fellowships during the 1959–60 academic year. The evaluation of each candidate's application is made by the Academy–Research Council selection panels and boards. The National Science Foundation will make the final selection of fellows and will announce the awards on 15 March 1959.

These fellowships are open only to citizens of the United States and are awarded solely on the basis of ability.

Graduate fellowships are available to those who are working toward the masters' or doctoral degrees in the first, intermediate, or terminal year of graduate study. College seniors who expect to receive a baccalaureate degree during the 1958–1959 academic year are also eligible to apply. Postdoctoral fellowships are available to individuals who, as of the beginning of their fellowship tenure, have a Ph.D. in one of the fields of eligibility or who have had research training and experience equivalent to that represented by such a degree. In addition, holders of the M.D., D.D.S., or D.V.M. degree, who wish to obtain further training for a career in research, are eligible provided they can present an acceptable plan of study and research. "Awards are not made to individuals to pursue a course of study designed to prepare them further for careers in medical practice and comparable fields; however, applications will be accepted from those who intend to obtain further training in one of the medical sciences directed toward a career in research."

All applicants for graduate (predoctoral) awards will be required to take an examination designed to test scientific aptitude and achievement. This examination, administered by the Educational Testing Service, will be given on 19 January 1959 at designated centers throughout the United States and certain foreign countries.

The annual stipends for graduate fellows are as follows: $1800 for the first year; $2000 for the intermediate year; and $2200 for the terminal year. The annual stipend for postdoctoral fellows is $4500. Dependency allowances will be made to married fellows. Tuition, laboratory fees, and limited travel allowances will also be provided.

Further information and application materials may be obtained from the Fellowship Office, National Academy of Sciences–National Research Council, 2101 Constitution Ave., NW, Washington 25, D.C. The deadline for the receipt of applications for regular postdoctoral fellowships is *22 December 1958* and for graduate fellowships, *5 January 1959*.

Neuromuscular diseases. The Sister Elizabeth Kenny Foundation has announced continuation of its program of postdoctoral scholarships to promote work in the field of neuromuscular diseases. These scholarships are designed for scientists at or near the end of their fellowship training in either basic or clinical fields concerned with the broad problem of the neuromuscular diseases.

The Kenny Foundation scholars will be appointed annually. Each grant will provide a stipend for a 5-year period at the rate of $5000 to $7000 a year, depending upon the scholar's qualifications. Candidates from medical schools in the United States and Canada are eligible. Inquiries regarding details of the program should be addressed to: Dr. E. J. Huenekens, Medical Director, Sister Elizabeth Kenny Foundation, Inc., 2400 Foshay Tower, Minneapolis 2, Minn.

Teacher training. The National Science Foundation invites universities, colleges, and other nonprofit institutions with appropriate research facilities to submit proposals for support of Research Participation Programs for Teacher Training. The NSF will support a limited number of experimental programs which will provide research experience during the summer months for teachers of science and mathematics in high schools and small colleges. The foundation will supply stipends and travel funds for approximately 700 teachers and will provide for expendable supplies, secretarial and administrative assistance, and other institutional costs directly attributable to the teacher training aspects of the programs.

Suggestions for preparation of proposals may be obtained from the Special Projects in Science Education Section, Scientific Personnel and Education Division, National Science Foundation, Washington 25, D.C. Proposals for programs beginning in the summer of 1959 should be comprehensive for all participating departments within an institutional unit, and should be received by the Foundation not later than *1 December 1958*.

Scientists in the News

SEVERO B. OCHOA, the newly designated recipient of the 1958 Borden Award for "outstanding contributions to medical research" and professor and chairman of the department of biochemistry of New York University College of Medicine, was the guest of honor at a reception given for him by his colleagues at N.Y.U.–Bellevue Medical Center on 20 October. Ochoa received the Borden Award at the traditional dinner given during the annual meeting of the Association of American Medical Colleges, which was held this year at the Sheraton Hotel in Philadelphia, Pa., on 13 October. Ochoa was selected particularly for "isolation of the enzyme in crystalline form which catalyzes the condensation of oxaloacetic acid and acetyl coenzyme A to form citric acid and for his discovery and studies of polynucleotide phosphorylase."

A compound apparently identical with the substance forming the basis of genetic inheritance in all living cells was synthesized by Ochoa and a team of scientists under his direction. This achievement is expected to shed increasing light on the basic chemistry of life, normal and abnormal; already it is considered a major step in the study of such abnormal growth as is involved in cancer.

ALAN T. WATERMAN, director of the National Science Foundation, and G. STAFFORD WHITBY, professor emeritus of rubber chemistry, University of Akron, received honorary degrees on 3 October during the observance of the 50th anniversary of the teaching of rubber chemistry at the University of Akron.

HERBERT C. BROWN, professor of chemistry at Purdue University and specialist in the chemistry of boron—a promising source of high-energy jet fuels—has won the 1959 William H. Nichols Medal of the American Chemical Society's New York Section. The gold medal will be presented at a section dinner in March.

VICTOR A. KOVDA of the U.S.S.R. has been appointed director of UNESCO's Department of Natural Sciences, succeeding PIERRE AUGER of France. He will take up the post on 1 January 1959. During the General Conference of UNESCO, which opens 4 November in Paris, he will serve as a consultant to the director-general on matters affecting the program of the department.

Kovda has been director of the Laboratory of Soil Reclamation at the Soil Science Institute, Moscow, since 1940, and since 1953 he has been professor of soil science at Moscow State University. He is a corresponding member of the Academy of Sciences of the U.S.S.R., vice-Chairman of the Fifth Commission of the International Society of Soil Science, and Chairman of the U.S.S.R. Arid Zone Committee.

ROBERT D. HUNTOON has been appointed to the newly created position of deputy director of the National Bureau of Standards. In this post, he will serve as alternate to the director in external matters and will exercise day-to-day direction and review of bureau programs. He will continue as associate director for physics.

Sir HANS A. KREBS, Whitley professor of biochemistry, Oxford University, recently presented two lectures at

the University of Texas Medical Branch, Galveston. The first, the Daniel W. Kempner Memorial Lecture, was on "The Regulation of Metabolic Processes," and the second, a Sigma Xi Lecture, was on "Synthesis of Cell Constituents from Two-Carbon Compounds."

JOSEPH C. HINSEY, director of the New York Hospital–Cornell Medical Center, received the first annual Abraham Flexner Award for distinguished service to medical education on 13 October at the 69th annual meeting of the Association of American Medical Colleges in Philadelphia. Former dean of Cornell University Medical College (1942–53), Hinsey continues to be professor of neuroanatomy there. In 1952 he served on the President's Commission on Medical Needs of the Nation. Currently he is chairman of the China Medical Board of New York and serves on the governing boards of the Memorial Hospital for Cancer and Allied Diseases, the Sloan–Kettering Institute, and Cornell University. He has been associate editor of the *Journal of Neuropathology and Experimental Neurology* since 1942.

The Albany Medical College, Union University, has conferred its second annual Honorary Lecture Award on PAUL A. WEISS, member of the Rockefeller Institute for Medical Research, and professor and chairman, department of developmental biology. The award, consisting of an honorarium and plaque, was presented on 9 October at the Albany Medical College. Weiss accepted the award with an address on "Biological Foundations of Tissue Repair."

The Public Health Service has announced three staff changes at the National Institutes of Health in Bethesda, Md.

C. J. VAN SLYKE, now an associate director of NIH, will become deputy director.

KENNETH M. ENDICOTT, now chief of the Cancer Chemotherapy National Service Center, National Cancer Institute, will become an associate director of NIH. His area of special staff responsibility will be the training programs and activities of the institutes' eight operating programs.

RICHARD L. SEGGEL, now director of the Office of Management Policy in the Department of Health, Education, and Welfare, will become executive officer of NIH. He will succeed ALBERT F. SIEPERT, recently named business manager of the newly created National Aeronautics and Space Administration.

Van Slyke, Endicott, and Seggel will all serve on the immediate staff of the director of the National Institutes of Health, James A. Shannon.

The Brewster Memorial Award, the highest honor of the American Ornithologists' Union, has been awarded to ARLIE W. SCHORGER, professor of natural history at the University of Wisconsin, for his work on the passenger pigeon. The union, an organization composed of scholars and laymen concerned with bird study, recently held its 75th anniversary meeting at the American Museum of Natural History. Schorger is the author of *The Passenger Pigeon: Its Natural History and Extinction*, considered to be the most comprehensive work ever written about this extinct species. Once one of the world's most abundant birds, the last passenger pigeon died in captivity in 1914.

DONALD B. LINDSLEY, professor of psychology at the University of California, Los Angeles is delivering the nine William James lectures at Harvard University. The lecture series, on the subject, "Brain Organization and Behavior," is scheduled for nine successive Mondays: 20 and 27 October; 3, 10, 17, and 24 November; and 1, 8, and 15 December. All lectures are open to the public. In addition, Lindsley is conducting a graduate seminar during the fall term on the psychophysiology of brain function.

ARTHUR C. COPE, chairman of the department of chemistry at Massachusetts Institute of Technology, has received the Charles Frederick Chandler Medal, which is awarded annually by Columbia University in recognition of achievement in pure or applied chemistry. Cope was honored for his pioneering work on the chemistry of medium-sized ring compounds and for his recognition of the transannular reaction, a new and unsuspected phenomenon in organic chemistry.

A. J. MACINTYRE of King's College, University of Aberdeen, Scotland, is serving this year as visiting research professor of mathematics at the University of Cincinnati, a new position in the Graduate School of Arts and Sciences.

HELEN A. HUNSCHER, chairman of the department of home economics at Western Reserve University, has been named the 1958 recipient of the Marjorie Hulsizer Copher Award, highest honor in the field of dietetics.

CHARLES G. MILLER, chemist and physicist, has been appointed director of research and development for the Isotopes Specialties Company, a division of the Nuclear Corporation of America. He is on leave from the University of California at Santa Barbara, where he is associate professor of physics and chief scientist of the radiological unit.

Recent Deaths

JOSEPH ARONSON, Philadelphia, Pa.; 69; professor of bacteriology at the Henry Phipps Institute of the University of Pennsylvania; professor of bacteriology and pathology at the University of Arkansas, 1911–14; was making a study of leprosy in Paramaribo, Surinam, at the time of his death; 18 Oct.

LAWRENCE B. CHENOWETH, Cincinnati, Ohio; 67; professor emeritus of hygiene at the University of Cincinnati; taught at Cornell University before joining Cincinnati in 1920; president of the American College Health Association in 1949, and former national president of Phi Epsilon Kappa; 17 Oct.

CLAYTON S. HITCHINS, New Haven, Conn.; 46; assistant clinical professor of obstetrics and gynecology at the Yale University School of Medicine; former chief of obstetrics at Grace–New Haven Community Hospital; 14 Oct.

OTTO HORNUNG, Jarvis Island, Gilbert Islands; American meteorologist, who was collecting data for the International Geophysical Year program on Jarvis Island in the Pacific; 11 Oct.

Sir DOUGLAS MAWSON, Adelaide, Australia; 76; noted antarctic explorer; until the International Geophysical Year, was the only trained scientist to lead major antarctic expeditions; professor of geology and mineralogy at Adelaide University, 1920–54; in three trips between 1907 and 1931, helped to map 2,250,000 square miles of Antarctica for Australia; established the first radio station in Antarctica; 14 Oct.

ROBERT REDFIELD, Chicago, Ill.; 60; professor of anthropology at the University of Chicago; specialist on life in primitive villages in Mexico, Yucatan, and Guatemala; chairman of the department of anthropology of the University of Chicago, 1947–49; and dean of the university's Division of Social Sciences, 1934–46; had been a visiting professor and lecturer at universities in Paris, India, and Peiping; 16 Oct.

IRVING J. SANDS, New York, N.Y.; 67; neurologist and psychiatrist; associate clinical profesosr of neurology at the College of Physicians and Surgeons of Columbia University from 1919 until his retirement in 1956; author of *Abnormal Behavior* and *Neuropsychiatry for Nurses*; 21 Oct.

JOHN S. STEWART, New York, N.Y.; 69; metallurgical engineer who worked in Canada, the Soviet Union, and the Belgian Congo; designed a lead smelter in Yugoslavia; developed an improved blast furnace in 1948; 14 Oct.

S. BENTON TALBOTT, Elkins, W.Va.; 56; since 1933 head of the department of biology at Davis and Elkins College, Elkins, W.Va.; former dean of the college and president of the West Virginia Academy of Science; 16 July.

Book Reviews

The March of Archaeology. C. W. Ceram. Knopf, New York, 1958. xviii + 326 pp. Illus. $15.

This latest work from the facile pen of Ceram is a companion volume to his earlier *Gods, Graves, and Scholars* and was planned in conjunction with that book. The pattern is similar, and the contents include the same general subject matter. In the present instance, however, the story is mainly told by pictures, the text being held to a minimum. The illustrations used were selected after long and careful sorting of pictorial material in institutions both in this country and abroad. Many are reproductions of new photographs, published for the first time. For the earlier periods of archeological activity, the excavation work and many of the finds are illustrated by contemporary drawings and engravings, while excavation work and finds relative to recent researches are depicted in excellent photographs.

For the most part, the archeology reviewed by Ceram is that generally referred to as "classic." This is attributable to his purpose in preparing the book—namely, the tracing of the historical and cultural continuity extending from Sumeria through Babylon, Assyria, Crete, Greece, and Rome to modern times. There is no reference to or discussion of the vast field of prehistoric archeology and the unraveling of the story of the cultural growth which led to the tremendous revolution in man's way of life that occurred in the New Stone Age, when he became a food producer instead of a food gatherer and was able to turn his efforts to things which culminated in the art objects and great cities described by Ceram.

In Book I the story begins with the finding in 1485, by workmen along the Appian Way, of a sarcophagus containing the perfectly preserved body of a girl of ancient Rome; it continues on through the discovery of the buried cities of Pompeii and Herculaneum and the part played by Johann Joachim Winckelmann in helping archeology get under way as a scholarly study of antiquity; it follows Heinrich Schliemann in his search for and finding of fabled Troy, his excavations there, and the subsequent completion of the Schliemann projects at Troy, Mycenae, and Tiryns by Arthur Evans.

Book II pertains to Egypt and starts with the observations of the German traveler Johannes Hellfrich, made in 1565, when he first saw the sphinx near the great pyramids; discusses the significance of the Egyptian sphinx and the work of numerous men who have tried to solve its riddle; describes the various pyramids and explains their purpose; gives careful consideration to the subject of mummies and mummification; and reviews the extensive excavations in the tombs in the Valley of the Kings, from the days of frankly acknowledged looting to the most recent and strictly scientific digging. Attention is also given to hieroglyphs, to the Rosetta stone, and to the deciphering of Egyptian inscriptions.

In Book III stories of early travelers to Babylon and Persepolis are recounted, the problems involved in the decipherment of cuneiform script are presented, and the excavations by Austen Henry Layard in the palaces of Nineveh, by Robert Koldewey at Babylon, and by Leonard Woolley at Ur are described. In the case of the latter there is reference to the methods employed in digging and preserving archeological materials.

The author digresses from his general Old World theme in Book IV and considers Middle American archeology—that is, the manifestations in Mexico and Central America. In that connection he reviews the first accounts of the conquest of Mexico, illustrating his remarks with pictures from native manuscripts recording the event, and tells how the Spaniards almost wiped out all possibility of understanding the history of the area by their methodical extirpation of the Indian culture. The impression made by the first specimens of Indian art to reach Europe is described, and several pictographic native manuscripts are considered in detail. Attention is given to the work of the early explorers Kingsborough, Waldeck, Stephens, and Catherwood, and illustrations from their publications are an important feature of the book. Reference is made to the important studies of the Abbé Brasseur de Bourbourg and, of course, to the more recent investigations by scholars from the United States and Mexico. The possibility of Egyptian and East Indian influences is reviewed, and the objections of Americanists to such ideas are mentioned.

Book V is devoted to retrospect and perspective and includes a chronological table of the history of archeology as it is delineated in the pages of this volume. In it the author points out that the 322 illustrations show Western man's growing awareness of his own past and illustrate the fact that, as more knowledge becomes available, the past is assuming wider and more global meanings. With respect to new discoveries he mentions the Dead Sea scrolls, recent finds in Jericho, the new information on the Hittites, wall frescoes in the Maya area, and the results now being obtained from underwater archeology and aerial surveys.

In his introduction Ceram calls attention to the fact that this volume, like its predecessor, is a literary work rather than a scientific one. In that he is correct. The lay reader no doubt will find much of interest in this "picture book to be read" and should add to his fund of knowledge by perusing it. Specialists may find some items which will be new to them. The chronological table will be useful for purposes of reference, although there may be disagreement about the importance of some of the discoveries which are included and about the omission of others. The numerous black and white illustrations are well chosen, and the 16 color plates, showing a wide variety of subjects, are unusually good.

As the publishers suggest, those who have read *Gods, Graves, and Scholars* will unquestionably enjoy this book, but it should prove equally enjoyable to those who are not familiar with its predecessor. It deals with art and archeology rather than with straight archeology, and for that reason it will no doubt be well received by the general reader.

FRANK H. H. ROBERTS, JR.
Bureau of American Ethnology, Smithsonian Institution

Queues, Inventories and Maintenance. The analysis of operational systems with variable demand and supply. Philip M. Morse. Wiley, New York; Chapman and Hall, London, 1958. ix + 202 pp. Illus. $6.50.

This is the first of what should be a very useful series of publications in the field of operations research. It is planned as a kind of expanded introduction to queuing theory; a second monograph is to be devoted to computational methods, machine techniques, and numerical tables applicable to the problems discussed in the present book. A possible third volume will be concerned with detailed solutions (with tables) of main-

tenance problems, to which the present book devotes a chapter.

Queuing theory was born over half a century ago, when Erlang analyzed telephone-traffic problems. Fluctuations in service demands, as varying numbers of customers began to dial numbers, posed problems in the utilization of facilities. To handle peak loads with zero or negligible waiting time would require uneconomically large facilities. Inadequate capacity leads to intolerable delays and customer dissatisfaction. This combination of a fluctuating demand for service coupled with penalties if too much or too little servicing capacity is provided is characteristic of queuing problems.

It is only in the last decade or so that the ubiquity of problems of this sort has been recognized and that "nontelephonic" studies have been made. The stacking of airplanes over an airport and the building of frequently idle runways are the penalty brackets of fluctuating air traffic. Similar problems arise with respect to toll booths on highways, bridges, and tunnels; docking facilities in ports; scheduling of public transportation; maintenance of inventories (here the penalty brackets are lost orders and excessive inventory costs); choice of the proper number of clerks and checkout aisles in a supermarket, of telephone clerks in a telephone-order retail business, of the number of spaces in a parking lot; or determination of the size of the maintenance crew needed to keep a number of machines in operation when breakdown occurs randomly.

One suspects that there must be many similar cases which are somewhat disguised, such as that of a manufacturing establishment with a variable demand for a particular technical service. The decision here is whether to contract for the services or acquire the necessary capability to perform them. Another case might be that in which one must decide whether to establish an enterprise when competing enterprises already exist. This could be profitable if customer queues have engendered dissatisfaction but could be disastrous if adequate service is available. Here, of course, the availability of other techniques of competition complicates the problem. When adequate service pre-exists, however, this factor might only shift the impact of the disaster to a different victim or otherwise distribute the losses.

This book will appeal to specialists in operations research and to others concerned with the technicalities of queuing problems in whatever context they occur. It partly fills a gap in the textbook literature which will be even better filled when the later monographs of the series appear. The mathematical level is not difficult, though mathematical maturity is assumed. As one would expect, some knowledge of probability theory is taken for granted. Indeed, I felt on a number of occasions that if the author had made a little more allowance for the "rustiness" of the mathematics of many scientists, ease of reading would be greatly increased for nonspecialists in operations research and the book would also appeal to many of the more able undergraduates. As it stands, probably only graduate students and the ablest undergraduates will be able to get through it.

The book's 11 chapters discuss arrival and service time distributions, single and multiple exponential channels, simulation of nonexponential distributions, transients, infinite queues, queue discipline and priorities, and problems of inventory control and of maintenance of equipment. Tables and graphs of relevant functions are provided. Calculations are made showing how to evaluate the balance between service cost and customers lost and between mean wait and service cost; customer impatience is discussed. Optimization of the number of service channels, effects of priorities on delays, and a number of inventory and maintenance "strategies" are also considered.

JEROME ROTHSTEIN
Edgerton, Germeshausen & Grier, Inc.
Boston, Massachusetts

The Chemistry of the Steroids. W. Klyne. Methuen, London; Wiley, New York, 1957. 216 pp. Illus. $3.50.

Chemistry of the Steroids. Charles W. Shoppee. Academic Press, New York; Butterworths, London, 1958. vii + 314 pp. $9.

These two monographs with the minor difference in title are written with a widely different end in view. The small monograph by Klyne is intended primarily for the nonchemical reader, and the major emphasis is given to the steroid hormones. It attempts to lay a foundation for the subject and to indicate the major properties and reactions of the naturally occurring steroids and their relatives. To me, the treatment appeared too specialized for biologists and perhaps better suited to a chemist interested in an introduction to this field of natural products. A series of references to reviews and texts appears at the end of the book.

Shoppee's monograph "sets out to present as concisely as possible the present state of knowledge." The more important references up to the end of 1955 and a few in 1956 are cited; this listing appears to be relatively complete. The highly compressed style will discourage the casual reader, but there is a wealth of well-presented and well-organized information. The inclusion of a great deal of subject matter that must be regarded as historical at this time seemed of questionable value to me, but this surely is a minor criticism of so great a task.

Both monographs are useful additions to the chemical literature and will find their place among the reference works in this very active field of investigation.

T. F. GALLAGHER
Sloan-Kettering Institute,
New York, New York

Historia Natural del Maíz. Separata de la Revista de la Academia Colombiana de Ciencias Exactas, Fisicas y Naturales, vol. X, No. 39. Daniel Mesa Bernal. The Academy, Bogotá, Colombia, 1957. 106 pp.

The expressed purpose of this publication is to present for readers of Spanish a panorama of the history and importance of maize in early times and a résumé of the theories about its center of origin. Two chapters outline the problem, give brief statements about the historical sources, and summarize the importance of maize as the key to pre-Columbian civilization in America.

In the discussion of the theory of Asiatic origin, the Oriental members of the Maydeae are unfortunately placed on an equal footing with those of America. The statement that, of these Old World genera, *Coix* is most closely related to maize cannot be accepted without more clarification. There seems to be something wrong with the statement about the depth at which fossil pollen of *Euchlaena* was found in Mexico.

Four areas—Mexico and Guatemala, Colombia and Venezuela, the Andean plateau, and the La Plata region—are discussed as possible centers of the origin of maize agriculture. The chapter on Colombia and Venezuela is particularly appreciated because of its full treatment of an area which has received too little attention in the past.

Both sides of each controversial point are given objectively, and there is seldom a hint as to which side the author prefers. This results in an array of ideas, some much sounder than others, which, without supporting evidence, seem to be of equal value. In fact, there is nothing to indicate that the author has made any study of the subject except from the literature. We may wish also that he had made himself a little more clear in discussing such things as degree of variation, number of varieties, and primitive characteristics.

A plate and 35 text figures break the monotony of the large, double-column, closely printed pages. A few typographical errors have been noted: misspelled names (Cutler, Weberbauer), a chapter incorrectly numbered (8 or 9), and a figure inverted (page 36).

The bibliography of 85 titles includes some interesting items which have been overlooked in earlier works of this sort but fails to include some works discussed in the text. Some of the citations are incomplete.

The author's purpose has been satisfactorily accomplished, and Spanish-speaking people should find the book an interesting introduction to both ancient and current thought about this fascinating subject. Students of the history of maize will find the book indispensable for the addition which it makes to our knowledge of the old literature.

PAUL WEATHERWAX
Indiana University

Science in Schools. Proceedings of a conference under the auspices of the British Association for the Advancement of Science. Held on April 17 and 18, 1958, at the Royal Geographical Society. W. H. Perkins, Ed. Butterworths, London, 1958. 150 pp. 15s.

The decorative design on the cover of this attractive little book provides a good indication of the content. It reads:

"Learning before luxury? Should schools receive a better share of the scientists who are graduating today? Science as an also-ran in girls' grammar schools? 'Just one period a week of nature study' for primary school science? How are we spending now . . . how much . . . how quickly should we expand?

"These and other topical questions on science education were discussed by certain leading industrialists, scientists and educationalists of our day at the April 1958 British Association Meeting. The papers now appear in eminently readable book-form. They will be of interest to all who believe that the development of science and technology cannot take place without a much bolder programme of rapid educational advance than any which has yet been promulgated."

The problems discussed by the speakers—Sir Ben Lockspeiser, Sir Solly Zuckerman, Sir Eric James, H. F. Boulind, M. G. Bennett, Dame Kathleen Lonsdale, Sir Raymond Priestly, and others—were, of course, the problems of British schools. But the discussion applies almost equally well to American schools, for problems concerning the education of future scientists and engineers and the education in science of students who will follow other career lines are much the same on both sides of the Atlantic.

Science in Schools offers a brief, thoughtful, well-integrated, and beautifully written discussion of those problems and of how, at least in part, they might be met.

DAEL WOLFLE
AAAS

Coral Island, Portrait of an Atoll. Marston Bates and Donald P. Abbott. Scribner's, New York, 1958. 254 pp. Illus. $4.95.

Coral Island is an interesting and factual account of the inhabitants, natural history, and surface structure of Ifaluk Atoll, a half-square-mile of land in the Caroline Islands of the tropical Western Pacific. A team of investigators under the auspices of the Pacific Science Board and the Office of Naval Research spent from June to November studying the plants, animals, supply of fresh water, cultivated foods and reefs of the area in relation to the economy and daily life of the Ifalukians. The authors give a detailed description of the people and their economy, based on the things they use from land and sea. A slight surplus of essential resources was found, except for fish, which were somewhat overexploited in the lagoon.

The research team lived as self-supporting and generous guests of the Ifalukians, some of whom became close friends of the scientists. The whole atmosphere was one of cooperation on a basis of social equality. This book is filled with intimate details of the personality of the Ifalukians and of their way of life, which, with respect to housing and to clothing (or lack of it), is ideally suited to climatic and personal needs. For them, however, flies, mosquitoes, and infections present especially difficult problems.

This book makes fascinating reading for anyone interested in people and natural history.

LEONARD P. SCHULTZ
Division of Fishes,
U.S. National Museum

Safety Techniques for Radioactive Tracers. J. C. Boursnell. Cambridge University Press, New York, 1958. 68 pp. $1.75.

The "poisonous" character of radioactive substances is well proven today. The normal human being has a natural radium content of about 10^{-10} g of radium-226 in his body, and the maximum permissible amount of this element for the entire body is 10^{-7} g. The maximum permissible concentrations of radium in air and in water are 8×10^{-12} μc/ml air and 4×10^{-8} μc/ml water, respectively. Still lower permissible concentrations for the entire body are given for the heavier elements.

Thus it becomes evident that radioisotopes have to be handled with special care and with strict observation of certain safety techniques. This little booklet gives a compendious survey of the basic techniques, in the first six chapters. In a seventh chapter the facts are summarized under the headings "Do not" and "Do." A bibliography of selected references, from which some of the data presented have been taken, is a welcome guide for the reader interested in details. The booklet will be of value to the student and to those engaged in practical isotope work.

A. T. KREBS
U.S. Army Medical Research Laboratory, Radiobiology Division, Fort Knox, Kentucky

Nicolaus Steno and His Indice. (Acta Historica Scientiarum Naturalium et Medicinalium, Edit. Bibliotheca Universitatis Hauniensis, vol. 15). Gustav Scherz, Ed. Munksgaard, Copenhagen, Denmark, 1958. 314 pp. Illus. Kr. 32.

Nicolaus Steno or, in the Danish vernacular, Niels Stensen (1638–1686), has gradually come to be recognized as one of the outstanding figures in the history of natural science. Despite the great tribute paid to Steno in Thomas Henry Huxley's address to the British Association in 1881, he had been so far forgotten that little more could be said of him in the standard histories of science and of medicine than that he discovered the parotid duct and turned theologian. Yet here is one who had discovered the Graafian follicle before de Graaf, Peyer's patches in the intestine before Peyer, and the tetralogy of Fallot before Fallot; was an exceptional comparative anatomist and zoologist; and, above all, was the father of modern geology, paleontology, and crystallography. The high position of Steno has become abundantly clear with the publication of his works, letters, and manuscripts. In 1910, Vilhelm Maar edited Steno's *Opera philosophica*; Knud Larsen and Gustav Scherz brought out, in 1941–1947, his *Opera Theologica*; then came the two massive folio volumes of his *Epistolae*, in 1952, edited by Gustav Scherz, who, in 1956, published a full-scale study, *Vom Wege Niels Stensens.*

The present work consists of a series of essays—five in English, two in German, one in French—which present an appreciation of Steno's life, scientific achievements, and influence. Added to these are Steno's *Index*, or catalog of his natural-history collection, and several hitherto unpublished documents. The volume is an important one, especially for the general reader who wishes to acquaint himself with this universal mind, which played an exceptional role in the development of modern science.

J. B. DEC. M. SAUNDERS
Department of Medical History and Bibliography, University of California Medical Center, San Francisco

Exploring the Distant Stars. Thrilling adventures in our galaxy and beyond. Clyde B. Clason. Putnam, New York, 1958. 384 pp. Illus. $5.

Most books which popularize astronomy are written in a highly conservative style and with a heavy syntax compared with Clyde Clason's. As he puts it, "Man, oh man, have there been changes made!" Even the professional astronomer may find the text highly entertaining because of the novelty of seeing astronomy expressed in, let us say, "sportscaster" English. Oddly enough, outright errors of fact are no more frequent than in some books written by people closer to astronomy than is Clason. The one legitimate objection to this book is that it is highly derivative. Clason modestly remarks, "Being a mere layman in astronomy, I probably did not look in the right places." Popular articles and books by astronomers and nonastronomers comprise most of his bibliography, and he does not consider newspaper stories beneath notice. Few really original sources are consulted. The book cannot be an authoritative source of astronomical information, but it is a lively rendition of astronomical miscellany.

The format is pleasing, although in view of the cheap cloth binding and the absence of halftones, the book's price is rather high. The index is extensive.

Clason is evidently a gentleman of the old school of education, for he refers confidently to "an old algebra textbook kicking around your house" when he invites his reader to join him in a computation of magnitudes. Many an author would steer gently around similar obstructions. Generally speaking, one has to admire Clason for his sincere belief that the chap who is used to a baseball score card will not find the astronomical game dragging in the tenth inning.

HUGH M. JOHNSON
Department of Mathematics and Astronomy, State University of Iowa

The Measurement and Appraisal of Adult Intelligence. David Wechsler. Williams and Wilkins, Baltimore, ed. 4, 1958. 297 pp. $5.

The new edition of Wechsler's book sketches the background and standardization of the new (1955) edition of the Wechsler Adult Intelligence Scale, which has become the standard clinical method of appraising mental ability of older persons. Testing and scoring procedure which appeared in previous editions of the book has been removed to the test manual. The description makes it clear that the changes in the test are minor in nature but constitute a substantial improvement in practicality and accuracy.

Many contentious statements of minor significance have been removed or altered in this edition, but Wechsler's views have not changed. He continues to emphasize the use of score patterns for diagnosis of psychopathology; the "signs" suggested have been changed negligibly by the volume of research that has been done since publication of the 1944 edition—research which casts doubt on the usefulness of many of them. One sentence suffices to dismiss without citation the substantial negative evidence on the diagnostic usefulness of variability within the subtest profile; the bit of positive evidence Wechsler offers is presented only sketchily. He handles inadequately Bayley's evidence that mental abilities increase during early adulthood; it is regrettable that he has not supported his own views on mental decline with any evidence from retests of the same persons. Wechsler devotes a chapter to factor analyses of subtests, and while he reaches no grossly erroneous conclusions, he is not at home with statistical reasoning and gains little from it.

Wechsler is a good observer and a sound practical test designer. His theoretical discussion remains vague and poetic, and his test interpretations are rooted more in personal experience than in systematic evidence. His scale represents the highest flowering of the pragmatic mental testing initiated early in this century, rather than a break into any new understanding of intellectual processes.

LEE J. CRONBACH
School of Education and Department of Psychology, University of Illinois

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Reports

Beneficiation of Soils Contaminated with Strontium-90: Beneficial Effects of Potassium

There appears to be a possibility that strontium, like calcium, exists in soils in forms that make it unavailable to plants and thus to the biosphere. Evidence from the fallout data of the Sunshine project (*1*) disclosed disparities between total fallout as judged from actual pot collection of rain and from plant contents and soil analyses; these disparities could be due to some type of chemical aging or of chemical inaccessibility to plants of the radiostrontium carried in the rain. R. Scott Russell (*2*) has noted that the availability of radiostrontium to plants is lowered on its addition to certain soils, and Lyle T. Alexander (*3*) and R. F. Reitemeier (*4*) both report evidence that the accessibility to plants of radiostrontium in certain soils can be reduced by something like 30 percent.

These results indicate the possibility that treatment of heavily contaminated soils with ordinary fertilizers in reasonable amounts may have beneficial effects. These effects might reduce the consequences of reactor accidents or of local fallout during wartime very considerably. It seemed to be reasonable that the formation of certain insoluble inorganic compounds, such as strontium sulfate, might produce such effects. Strontium sulfate occurs in some soils (*3*) as the mineral celestite, and it might be expected to be sufficiently insoluble to accomplish at least a partial segregation of soluble strontium that is introduced into the soil. It is so insoluble [the solubility product is 7.6×10^{-7} at 25°C (*5*, p. 322)] that it seemed likely that, in contrast to gypsum ($CaSO_4 \cdot 2H_2O$) [with solubility product (*5*, p. 320) of 2.4×10^{-5} at 25°C], which apparently can feed calcium into plants, the strontium in strontium-sulfate might be truly unavailable to plant life. On the other hand, similar proposals with respect to barium had been tested by Bradfield (*6*) and by Robinson, Whetstone, and Edgington (*7*), and the results had shown that barium sulfate, which is even less soluble than strontium sulfate, could be utilized by plants in certain soils. However, the possibility seemed to exist that the addition of sulfate to contaminated soils might be helpful, so an investigation was undertaken.

During the course of the investigation it was suggested (*8*) that potassium might have a considerable beneficial effect with respect to radiostrontium absorption, as earlier work (*9, 10*) had indicated. As a result of these suggestions, a search for a specific potassium effect was also undertaken.

This report describes the experiments made to test these two proposals.

Soil from Washington, D.C. (from a garden at the Geophysical Laboratory of the Carnegie Institution of Washington, 2801 Upton Street, N.W.) was used by mixing two parts of soil with one part of the commercial soil thinner Vermiculite and with one part of horse-manure fertilizer. The soil used to make the mixture had 32 milliequivalents of exchangeable calcium per 100 g. To about 2 lb of this mixture was added, in very dilute aqueous solution, approximately 10 μc of Sr^{90}. Four earthen pots (A, B, C, and D) were used for trial with radish seeds for testing the efficacy of the addition of SO_4^{--} and of K^+ in the reduction of plant pickup of the radiostrontium.

Pot A, containing 370 g of the contaminated soil mixture, was prepared as follows, within a few minutes after the addition of the radiostrontium to the soil. To it, in dilute aqueous solution, was added 32 mg of ordinary nonradioactive strontium, as nitrate. The soil was stirred and made into a thick mud by further addition of water. After this mixture had stood for about 15 minutes, 35 mg of K_2SO_4 was added, in dilute aqueous solution, and stirred in. After one crop had been produced, 81 mg of strontium, as nitrate, and 200 mg of K_2SO_4 were added, in the same manner.

Pot B was prepared in exactly the same way, except that no sulfate was added. After the first crop, 265 mg of potassium nitrate was added to test the potassium effect. No additions whatsoever were made to pot C, except for the tracer radiostrontium; this pot served as a control. Pot D was filled with the pure soil, unfertilized and untreated with Vermiculite. To it was added radioactive strontium in the form of solid, insoluble strontium sulfate, 690 mg of the radioactive strontium sulfate being used to 726 g of soil, the two being intimately mixed before the radish seeds were planted.

The pots were planted with radish seeds and cultivated by being set in the ground out in the open during the summer or by being exposed to a bank of fluorescent lights indoors in the winter. At maturity the plants were ashed (after careful washing), the ash was dissolved in dilute hydrochloric acid, and sodium carbonate solution was used to precipitate the insoluble hydroxides and carbonates. The insoluble hydroxides and carbonates were measured for Sr^{90} content. The results are shown in Table 1.

The results of these experiments in-

Table 1. Effect of sulfate and potassium treatment of radiostrontium-contaminated soils on the availability of radiostrontium to radish crops. In column 2, each entry represents findings from one crop.

Conditions	Sr^{90} content of radish ash carbonates (arbitrary units)
Pot A (370 g mixture of soil and Vermiculite)	
8.9 mg of Sr/100 g, as nitrate, + 9.5 mg of K_2SO_4/100 g	0.63
Above + 22 mg of Sr/100 g, as nitrate, + 50 mg of K_2SO_4/100 g	0.64, 0.58
Pot B (356 g mixture)	
9 mg of Sr/100 g, as nitrate	0.81
Above + 72 mg of KNO_3/100 g	0.62, 0.63
Pot C (380 g mixture)	
No additions, except tracer Sr*	1.00, 1.01, 0.98
Pot D (726 g soil only)	
43 mg of Sr*/100 g, as Sr^*SO_4	0.90

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* 125, 16 (1957)].

dicate clearly that the addition of sulfate is not very effective as a means of reducing radiostrontium pickup by crops grown on contaminated soils. Although the addition of soluble strontium does seem to have some effect, the principal reduction observed was that effected by the addition of potassium; for potassium, in amounts as low as about 60 lb per 2 million lb of soil (or about 30 lb per acre for normal 2-in. depth of penetration of water-soluble fallout), something like a 40-percent reduction of radiostrontium uptake was observed.

Although these experiments show that radish plants in certain kinds of soil certainly can utilize the strontium in strontium sulfate, and that the formation of radiostrontium sulfate does not necessarily reduce the uptake of radiostrontium, the positive effect of potassium is established. It is possible that other fertilizers or other additives may have a more marked effect than either the fertilizer or the Vermiculite used in this investigation.

The effects observed by Russell, Alexander, and Reitemeier may involve effects other than those tested here. Certainly one knows that, as strontium lies in the soil, it is very likely eventually to be incorporated into large crystals, in which form it will become physically unavailable to the plants. And so the possibility of chemical aging, taking place slowly over several years, exists. It does not seem likely, however, that this process will be of sufficient magnitude to restore heavily contaminated soil to a useful condition, and further work needs to be done on methods of quick beneficiation.

W. F. LIBBY*

Geophysical Laboratory,
Carnegie Institution of Washington,
Washington, D.C.

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* On leave from the University of Chicago.

5 June 1958

Purine Catabolism in Drosophila melanogaster

Recently, it has been demonstrated that an eye color mutant, *rosy*^{2} (*ry*^{2}), does not contain isoxanthopterin which occurs widely in *Drosophila* (*1*). It has been reported that 2-amino-4-hydroxypteridine (AHP) is oxidized to isoxanthopterin by an enzyme prepared from *Drosophila* (*2, 3*) and named pterine dehydrogenase (*3*); xanthine is also converted into uric acid by the same enzyme (*2*), and xanthine oxidase is also capable of oxidizing AHP to isoxanthopterin (*4*).

I have found that the mutant *ry* does not contain a trace of uric acid at any developmental stage. Therefore, purine compounds and the activity of xanthine oxidase both in a wild type (Oregon-R) and in the mutant *ry* of *D. melanogaster* were investigated. Purine compounds were detected by paper chromatography. The results are shown in Table 1.

It was discovered that *ry* does not contain isoxanthopterin at any developmental stage, but rather contains a larger amount of AHP than does the wild strain at the pupal stage. It is well known that, as a rule, uric acid is a final product of purine catabolism in insects. On the other hand, mutant *ry* accumulates a larger amount of hypoxanthine, instead of uric acid. The occurrence of hypoxanthine was identified by the absorption spectrum of material isolated from *ry*, and xanthine in pupae and adults of *ry* was also demonstrated by paper chromatography.

The uric acid content of *D. melanogaster* was determined by the reduction of optical density at 295 mμ (*4*). The wild strain has the enzyme, but the *ry* strain does not. Furthermore, it seems that the enzyme is a true dehydrogenase, because it requires methylene blue or diphosphopyridine nucleotide (DPN) as an electron acceptor.

In some double mutants homozygous for *ry*, such as *v : ry*, *cn : ry*, *bw : ry*, and *se : ry*, neither isoxanthopterin nor uric acid is found to any extent in any developmental stage. Among them, *v : ry* and *cn : ry* have a light pinkish-red eye pigment, but *bw : ry* is similar in phenotype to *bw*, and *se : ry* is similar to *se* phenotypically. However, these strains have the same amount of hypoxanthine in each pupal stage as does the *ry* strain.

From these results, it seems that in *Drosophila* uric acid is produced from xanthine and hypoxanthine along the general pathway (*5*) shown in the following scheme.

Hypoxanthine → xanthine → uric acid

The deficiency of both isoxanthopterin and uric acid in *ry* strains may be due to the lack of xanthine oxidase. There is still a problem whether or not xanthine oxidase and pterine dehydrogenase are the same enzyme, and further researches are being carried out along this line (*6*).

Table 1. Pteridines and purines occurring in strains Oregon-R and *ry* of *D. melanogaster*.

Substance	Larvae	Pupae	Adults
Strain Oregon-R			
AHP	±	+	±
Isoxanthopterin	±	++	+
Hypoxanthine and xanthine	±	±	±
Uric acid	±	+	+
Strain ry			
AHP	±	++	+
Isoxanthopterin	–	–	–
Hypoxanthine and xanthine	±	++	+
Uric acid	–	–	–

T. MORITA

Department of Biology,
Osaka University, Osaka, Japan

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6. I am indebted to Dr. H. Kikkawa (Osaka University) and to Dr. C. Oshima (National Institute of Genetics) for their invaluable advice and encouragement. The greater part of this work was performed at the National Institute of Genetics in Misima, Japan.

27 May 1958

Cobalt Activation of Fatty-Acid Synthesis in Yeast Homogenates

Abstract. The incorporation of acetate into lipids in homogenates of *Saccharomyces cerevisiae* was inhibited at low concentrations of ethylenediaminetetraacetate, under both aerobic and anaerobic conditions. Of various cations tested, none could effectively reverse this inhibition. However, Co^{++} completely restored the synthesis of fatty acids, but not of nonsaponifiable lipids.

Previous reports from this laboratory have dealt with the synthesis of lipids in yeast cells (*1*) and in extracts prepared from yeasts (*2*). It has been shown that cell-free preparations incorporate acetate into various cellular lipids and that a particulate fraction consisting of uniform particles, of the order of 30 mμ in diameter, plus the soluble supernatant is required for this activity (*2*).

During the course of the studies de-

scribed in this report (*3*), it was found that the addition of ethylenediaminetetraacetate (EDTA) to crude homogenates severely inhibits the incorporation of acetate into lipids, and that cobalt reverses this effect specifically with regard to fatty acids. For these experiments, cells of *Saccharomyces cerevisiae*, strain LK2Gl2, were cultivated, harvested, and broken according to methods previously described (*2*). The resulting crude homogenates contained a large particle fraction, necessary for maximal respiration of the extracts, as well as the two fractions mentioned above. The homogenates were incubated for 4 hours in air, or under 100-percent CO_2, as indicated in Table 1, after which they were hydrolyzed and assayed for radioactivity in the fatty acids and the nonsaponifiable lipids, as described earlier (*2*).

The results of representative experiments are recorded in Table 1; from these, several conclusions can be drawn. The addition of EDTA in final concentrations as low as 0.0025*M* resulted in drastic inhibition of acetate incorporation into lipids without significant lowering of the rate of oxygen uptake. Indeed, there was usually a concomitant increase in the rate of respiration in the presence of EDTA (Table 1, experiments 1 and 3). That the primary effect of this chelating agent is not on the energy-generating system of these homogenates was further indicated by the fact that EDTA was similarly effective under anaerobic conditions (Table 1, experiment 2).

Various cations were added to this system in the presence of 0.0025*M* EDTA in order to ascertain whether any one of them would reverse the inhibitory effect, and the following proved to be ineffective at final concentrations of up to 0.005*M*: Ca^{++}, Zn^{++}, Fe^{++}, Mg^{++}, Cu^{++}, Fe^{+++}, Al^{+++}, Ba^{++}, and Sr^{++}. Under these conditions, Ni^{++} and Mn^{++} were somewhat active in potentiating the effects of EDTA, while Co^{++} consistently reversed the inhibitory effect of EDTA on the incorporation of acetate into the fatty-acid fraction but not its effect on the incorporation of acetate into the nonsaponifiable lipids (Table 1, experiments 2 and 3). Indeed, under aerobic conditions, the addition of Co^{++} alone frequently increased the level of incorporation into fatty acids above that of the controls. It is interesting to note that, under anaerobic conditions, the concentration of cobalt in the system may be very critical. For example, the presence of 0.0025*M* cobalt alone routinely inhibited acetate incorporation significantly (Table 1, experiment 2). Upon the addition of an equimolar amount of EDTA to such a system, cobalt became a potent activator of fatty acid synthesis, thus suggesting that the EDTA effectively tied up the excess (inhibitory) cobalt.

Earlier studies on the effect of chelating agents on the synthesis of lipids by intact rat liver cells (*4*) indicated that EDTA was ineffective in reducing acetate incorporation. However, since the possibility exists that the cells were impermeable to this substance, it may be unwarranted to compare the results of that study to those reported here. Of greater interest are the recent observations (*5*) that EDTA causes a deterioration or degradation of the particulate matter of microbial homogenates and that certain cations protect against this effect. It may well be, therefore, that acetate incorporation is reduced, in these studies, because of the loss of particle structure, rather than because of a direct effect on one or more enzymes concerned in the biosynthesis of lipids. Nevertheless, studies are now in progress to test the effect of EDTA and cations on enzymes involved in fatty-acid synthesis. The first series of experiments, designed to test the acetate-activating enzyme (*6*) in these homogenates, revealed this enzyme to be relatively insensitive to EDTA. For example, on the addition of EDTA at a final concentration of 0.0025*M*, acetate activation was decreased by about 20 percent. Furthermore, cobalt did not protect against this small degree of inhibition. Thus, this enzyme does not appear to be directly involved in the cobalt stimulation of fatty-acid synthesis in these homogenates.

HAROLD P. KLEIN

Biology Department, Brandeis University, Waltham, Massachusetts

Table 1. Effect of ethylenediaminetetraacetate and cobalt on acetate incorporation into lipids in extracts of *Saccharomyces cerevisiae*. Vessels for these experiments were set up in duplicate and contained 1.5 ml of yeast homogenate (25 to 30 mg of protein), 5 μmole of adenosine triphosphate, 3 μmole of acetate (5×10^{-5} count/min), and additions, as indicated, in a total volume of 1.9 ml. All experimental values were obtained by averaging the results from each set of duplicates.

Additions	Gas Phase	Acetate incorporation: Nonsaponifiable lipids (count/min)	Acetate incorporation: Fatty acids (count/min)	Q_{O_2}*
		Experiment No. 1		
None	Air	16,200	23,500	4.2
EDTA(0.0006*M*)	Air	15,000	15,280	8.2
EDTA(0.0009*M*)	Air	9,800	8,800	8.1
EDTA(0.0013*M*)	Air	7,240	5,000	9.1
EDTA(0.0025*M*)	Air	2,450	1,860	8.2
EDTA(0.005*M*)	Air	1,100	1,200	8.4
		Experiment No. 2		
None	CO_2	31,400	96,500	
EDTA(0.0025*M*)	CO_2	2,300	12,700	
EDTA(0.0025*M*) + $CoCl_2$(0.0025*M*)	CO_2	4,300	218,000	
$CoCl_2$(0.0025*M*)	CO_2	16,400	47,000	
		Experiment No. 3		
None	Air	7,600	14,400	3.7
EDTA(0.0025*M*)	Air	800	2,200	5.8
EDTA(0.0025*M*) + $CoCl_2$(0.005*M*)	Air	1,800	27,400	5.7
$CoCl_2$(0.005*M*)	Air	6,200	21,300	3.1

* Q_{O_2} refers to microliters of oxygen consumed per hour per milligram of protein.

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11 March 1958

Inhibition of Human Plasma Cholinesterase in vitro by Extracts of Solanaceous Plants

While attempting to determine residues of organic phosphorus insecticides in various plant tissues by the method of cholinesterase inhibition, we found that potato (*Solanum tuberosum* L.) tissue presented an unexpected problem (*1*). Aqueous extracts of foliage and tubers which had not been treated with insecticide still gave a positive test— that is,

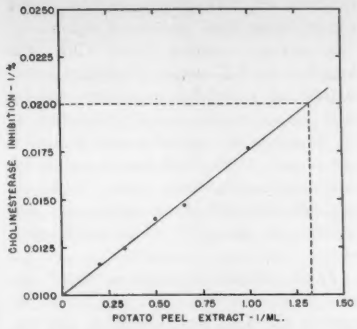

Fig. 1. Reciprocal of volume of potato-peel extract versus reciprocal of resulting percentage of inhibition of cholinesterase present in 5 ml of human blood plasma. Maximal percentage of inhibition, in this case, equals 1/0.01, or 100 percent. Volume of extract resulting in half-maximal inhibition equals 1/1.32, or 0.76 ml.

inhibited human plasma cholinesterase. Subsequently, aqueous extracts of foliage and roots of tomato (*Lycopersicon esculentum* Mill. var. *commune* Bailey) and fruit of egg plant (*Solanum melongena* L.) were also found to inhibit cholinesterase. Since these species were all members of the Solanaceae, other local representatives of this family were investigated in order to delimit the taxonomic distribution of the inhibitory substances.

Plants assayed were for the most part collected from the field (*2*). Greenhouse-grown plants were avoided because of the possibility of contamination with cholinesterase-inhibiting insecticides. One part by weight of fresh tissue was homogenized with four parts by volume of distilled water for 3 minutes at room temperature in a Waring Blendor. The homogenate was filtered through cheesecloth, and the *p*H of the filtrate was adjusted to 7.35. Aliquots of this filtrate, ranging from 0.5 to 10 ml, were added to 5 ml of human blood plasma (*3*) in each of a series of 50-ml volumetric flasks. The total volume was brought to 50 ml with distilled water, and the contents were thoroughly mixed. The flasks were allowed to incubate for 70 minutes at 37.5°C, after which period 1-ml aliquots were removed and assayed for remaining cholinesterase activity by the potentiometric method of Hensel *et al.* (*4*), as modified by Curry (*5*). Calculation of percentage of cholinesterase inhibition was based on the average cholinesterase activity observed for two flasks which contained the same quantity and dilution of plasma but no inhibitor. A straight line resulted when the reciprocal of the concentration of the inhibitor was plotted against the reciprocal of the percentage of inhibition (Fig. 1). The reciprocal of the ordinal intercept was taken as maximal percentage of inhibition, and the concentration of extract resulting in half maximal inhibition ($I_{1/2\ max.}$) was determined from this value.

Potato tissue was most extensively studied. The tuber peel was found to contain from 10 to 40 times the concentration of inhibitor present in the innermost flesh. A series of six determinations on peel extracts resulted in a mean $I_{1/2\ max.}$ of 0.6 ± 0.1 ml. The dry-solid content of potato-peel extracts averaged 89 mg/ml, hence the $I_{1/2\ max.}$ was equivalent to 53 mg of dried extract (six-tenths of 89). The potency of the extract decreased on standing at 5°C in a refrigerator; in two instances, approximately half the activity was lost in 10 days. Extracts of tuber sprouts were found to be as inhibitory as peel extracts. The inhibitor was also found in potato leaves and flowers and, in lesser concentration, in the stems. The $I_{1/2\ max.}$ values for extracts of berries of potato, horse nettle (*Solanum carolinense* L.), common nightshade (*S. americanum* Mill.), and ground cherry (*Physalis* sp.), were 0.5, 2, 2, and 7 ml, respectively. However, the order of potency could depend upon the relative ripeness of the berries.

Tissues of other solanaceous plants which possessed cholinesterase inhibitory substances included leaves of tobacco (*Nicotiana tabacum* L.), leaves and flowers of petunia (*Petunia hybrida* Vilm.), leaves of Jimson weed (*Datura stramonium* L.), foliage of buffalo bur (*Solanum rostratum* Dunal), and the leaves and berries of nightshade bittersweet (*S. dulcamara* L.). Extracts of ripe fruits of garden huckleberry (*S. nigrum* L.), ripe tomato fruits, and nearly mature Jimson-weed pods produced little or no inhibition. Tissues of Solanaceae found to be relatively inactive included the foliage and fruits of matrimony vine (*Lycium halimifolium* Mill.) and pepper (*Capsicum frutescens* L.). Local representatives of 21 other higher plant families were also assayed, but no inhibitory activity was found.

Preliminary tests indicate that the inhibitor is soluble in water and in 95-percent ethanol but insoluble in acetone, ether, or chloroform. It survives boiling in water and heating in weakly acidic or basic solution. The inhibitory substance does not appear to be related chemically to some of the better known alkaloids of the Solanaceae. It remains soluble in water at *p*H 9.5 and does not partition into chloroform or ether from alkaline solution. These properties differ from those of the steroidal amine glucosides—for example, solanine and tomatine (*6*), or the tropane alkaloids (*7*). The inhibitor does not partition from water into ether at *p*H 3, as one would expect of phenols or other weak acids.

Others (*5, 8*) have reported difficulty when using cholinesterase inhibition assays for insecticide residues directly on aqueous extracts of potato tissue and have attempted to avoid this interference by extracting the residues into chloroform prior to assay. It is now apparent that the source of interference in potatoes, as well as in several other solanaceous species, is a highly water-soluble inhibitor of human plasma cholinesterase. Cholinesterase inhibitors have been reported to be present in other plant families, including Buxaceae, Leguminosae, Loganiaceae, Malvaceae, Rosaceae, Rubiaceae, and Theaceae (*9*).

WALLACE H. ORGELL
KUNDA A. VAIDYA
PAUL A. DAHM
Department of Zoology and Entomology, Iowa State College, Ames

References and Notes

1. This report is journal paper No. J-3410 of the Iowa Agricultural and Home Economics Experiment Station, Ames (project No. 1351). This investigation was supported in part by research grant RG-4066 from the Division of Research Grants, U.S. Public Health Service.
2. We acknowledge the kind assistance of those members of the departments of botany, genetics, horticulture, and zoology and entomology at Iowa State College who aided us in obtaining many of the plant species used in these experiments.
3. Initially, quantities of pooled, outdated human blood plasma were supplied by Chemagro Corp., New York, N.Y. Later, outdated lots of plasma and of whole human blood were obtained from Mary Greeley Hospital, Ames, Iowa, and from Iowa Methodist and Veteran's hospitals, Des Moines.
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2 June 1958

Pyridine-2-Aldoxime Methiodide and Diacetyl Monoxime against Organophosphorus Poisoning

Three oximes have recently been proposed as antidotes against intoxication by organophosphorus compounds—pyridine-2-aldoxime methiodide (PAM) (*1*), diacetyl monoxime (DAM), and monoisonitrosoacetone (MINA) (*2*); it has been found that their effectiveness against the different poisons varies greatly.

We have observed the antidotal properties of DAM, the least toxic of the three oximes, and its use in a mixture with PAM. Furthermore, since the action of PAM has been attributed mainly to its ability to reactivate inhibited cholinesterase (ChE) (*3*)—a point which has been questioned by Hobbiger (*4*)—we determined the residual ChE in the brain and blood of animals which had either died from, or had survived, the poisoning.

Fresh saline solutions of tetraethylpyrophosphate (TEPP), diisopropyl fluorophosphate (DFP), and bis(dimethylamido)fluorophosphate (Dimefox) were used. Diethyl-*p*-nitrophenyl phosphate (Paraoxon) was tested in distilled water. The oximes PAM and DAM were dissolved in saline, the latter oxime being neutralized to *p*H 7.4. The animals used were white male mice weighing 20 ± 2 g. Final readings of results were recorded after 24 hours. The solutions of the organophosphorus compounds and the oximes were so adjusted that in each case 0.2 ml per 20 g of body weight was introduced. For the tests of the protective action, the antidote was administered intraperitoneally exactly 1 minute after the subcutaneous injection of the poison. The possibility of a direct chemical interaction between PAM and DAM in the synergism experiments was excluded by administering, in some of the experiments, PAM intramuscularly and DAM intraperitoneally. In all cases control groups of mice were injected with (i) the corresponding quantities of antidotes used and (ii) multiples of the LD_{50} of the poisons employed. The LD_{50} (subcutaneous) of the phosphorus compounds, expressed in milligrams per kilogram of body weight and calculated by the log probit method (*5*), were as follows: TEPP, 0.52; Paraoxon, 0.78; Dimefox, 4.8; DFP, 4.0.

The ChE activity was measured by Hestrin's method (*6*); the brain was extracted with chloroform according to the method of Kewitz (*3*) before testing. For the survivors, the ChE was determined when the symptoms of poisoning had disappeared, 45 minutes to 1 hour after intoxication. In order to obtain the normal ChE values, 100 samples of blood and ten of brain were examined separately. The average normal blood ChE was found to be 2.17 μmole (standard error, 0.028) of acetylcholine hydrolyzed by 0.05 ml of whole blood incubated at 25°C during 25 minutes, and the average normal brain ChE was found to be 2.04 μmole (standard error, 0.068) of acetylcholine hydrolyzed by 2.5 mg (dry weight) of brain at 25°C during 30 minutes.

Table 1 shows the results obtained. An analysis of covariance was carried out on part of the data from Table 1. The results of the randomized design with three replications of ten animals for each PAM-DAM dose combination against 3 LD_{50} of TEPP were transformed into log doses and empirical probits. A regression of probits protection on log doses PAM and DAM was calculated; this gave significant positive coefficients for both (*7*). As DAM alone gives no protection against 3 LD_{50} of TEPP, it was concluded that PAM and DAM are synergists against TEPP poisoning. It was found that DAM also enhanced the action of PAM against Dimefox, but not against Paraoxon. For DFP poisoning, the results obtained are similar to those reported by Kewitz *et al.* (*8*), and no significant synergistic effect has been found. When DAM was tested against 1 LD_{50} of TEPP, it showed some protective effect, but less than PAM; these results compare closely with those obtained by Askew (*2*) on rats. Against 1 LD_{50} of Dimefox and 2 LD_{50} of Paraoxon, DAM was found to be ineffective.

Table 2 gives the ChE values found in dead and surviving animals. Practically no difference was observed in the two cases.

These results (*9*) do not appear to support the assumption that the therapeutic action of the antidotes is based entirely on the reactivation of ChE (*10*).

H. Edery
G. Schatzberg-Porath
Israeli Institute for Biological Research, Ness-Ziona

Table 1. Protective effect of PAM and DAM against organophosphorus intoxication.

Organophosphorus compound	Multiple of LD_{50}	PAM (mg/kg)	DAM (mg/kg)	Total No. of animals injected*	Survivors
TEPP	2.3	50		20	2
TEPP	2.3	50	200	20	18
TEPP	3.0	50		30	0
TEPP	3.0	50	150	30	8
TEPP	3.0	50	200	30	5
TEPP	3.0	70		30	7
TEPP	3.0	70	150	30	17
TEPP	3.0	70	200	30	19
TEPP	3.0	90		50	22
TEPP	3.0	90	150	50	41
TEPP	3.0	90	200	30	22
Dimefox	2.0	90		40	21
Dimefox	2.0	90	150	40	25
Dimefox	3.0	90		30	7
Dimefox	3.0	90	150	30	20
Paraoxon	5.0	90		20	14
Paraoxon	5.0	90	150	20	17

* Separate experiments with 10 mice each.

Table 2. Cholinesterase activity in the blood and brain of surviving and dead mice poisoned with 3 LD_{50} of TEPP and (except in experiment No. 5) treated with PAM or DAM, or with both. In each case the result given is for an average of four mice, except for experiment No. 4, where the results are given for an average of ten mice. The numbers in parentheses indicate standard errors in percentage of normal values.

Expt. No.	PAM (mg/kg)	DAM (mg/kg)	Percentage of normal ChE activity			
			Blood		Brain	
			Survivors	Dead	Survivors	Dead
1		200*		9 (4)		42 (5)
2	90	150*	71 (6)	67 (6)	30 (8)	27 (7)
3	90		73 (4)	61 (6)	45 (7)	36 (14)
4	90	150	67 (4)	72 (1)	23 (6)	20 (2)
5				21 (6)		37 (6)

* DAM injected 5 minutes before injection of TEPP.

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24 April 1958

Concentrations of Radioactive Materials in the Air during 1957

The present concern over the possible hazards associated with the introduction of man-made radioactive materials into the air has been occasioned, in part, by a lack of awareness of the levels of activity of the naturally occurring radioactive materials in the air. It is thought appropriate at this time to present the most recent information obtained from a continuing study conducted by the U.S. Naval Research Laboratory on the radioactivity of the air.

The concentration of radon, thoron, and fission products in the air is obtained from the changes in the rate of decay, over a 16-hour period, of radioactive particulate matter collected on efficient filters (with 98-percent retention of particles as small as 0.3 μ in diameter) through which 900 to 1300 m^3 of air have passed during the previous 24 hours (*1*). Measurements were made daily on identical equipment located at Washington, D.C.; Yokosuka, Japan; Kodiak, Alaska; and Little America, Antarctica. Calibrated radioactivity standards were counted daily in each unit. The average of the daily measurements covering the full year of 1957, with the exception of short periods when the equipment was undergoing repair, is presented in Table 1. The radon concentration is that occurring in the early afternoon at each site and generally represents the minimum concentration during the 24-hour collection period.

As may be seen, the bulk of the radioactivity is due to the ever-present radon and its decay products, which result from radioactive decay of radium in the soil and the consequent diffusion of the gaseous radon daughter into the air. The concentration of radon and thoron in the air is thus dependent on the location of land masses relative to the prevailing winds passing over the collecting site (*1*). In spite of the fact that the concentration of air-borne fission products in the Washington area was unusually high during 1957, due to the extensive nuclear test series in Nevada, this man-made material amounted to only 1.2 percent of the radon concentration. The other collection sites show similar values for the fission-product–radon ratios. The concentration of thoron is roughly equal to that of the fission products in every case. When one takes into account the series of radioactive products associated with each radon decay, the additional external dose due to the fission products in the air is found to be inconsequential.

Table 1. Geographical distribution of atmospheric radioactivity during 1957 (activity in micromicrocuries per cubic meter).

	Radon	Thoron	Fission Products
Washington, D.C.	172	2.3	2.1
Yokosuka, Japan	54	0.48	0.66
Kodiak, Alaska	7.3	0.042	0.16
Little America, Antarctica	1.5	0.01	0.019

LUTHER B. LOCKHART, JR.
U.S. Naval Research Laboratory
Washington, D.C.

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19 May 1958

On the Effect of Inorganic Phosphate on Hexose Phosphate Metabolism

In 1935 Theorell (*1*) showed that inorganic phosphate (P_i) (*2*) inhibited glucose-6-phosphate dehydrogenase, the enzyme catalyzing the first reaction of the hexose monophosphate shunt pathway. It is also well known that P_i plays an essential role in the Embden-Meyerhof glycolytic scheme. These two observations suggest the possibility that the local intracellular P_i level could determine the pathway of glucose metabolism. A high P_i concentration should inhibit the shunt but allow glycolysis to proceed, whereas a limiting P_i concentration should exert the opposite effects. This report provides experimental evidence that the P_i concentration in extracts of ascites tumor cells does produce this effect on hexose phosphate metabolism. The reactions involved are shown diagrammatically in Fig. 1.

Ehrlich mouse ascites tumor cells were removed from the animal, washed two times with 0.1*M* Tris buffer, *p*H 7.4, and then homogenized in 0.01*M* Tris buffer, *p*H 7.4, for 20 seconds with micro glass beads in a Nossal shaker (*3*). The cell debris and mitochondria were removed by centrifugation. The temperature during the preparation of this enzyme extract was maintained at 4°C.

In one series of experiments, 0.2 ml of this extract with added TPN^+ was incubated in the presence or absence of phosphate buffer with (i) G-6-P and (ii) glucose-1-C^{14}. At the end of the incubation period the reaction was stopped by placing the vessels in a boiling water bath or by adding an equivalent volume of 10 percent trichloracetic acid. The G-6-P that remained was determined by treatment of the deproteinized extract with 100-fold purified glucose-6-phosphate dehydrogenase (*4*) and excess TPN^+. In the experiments with glucose-1-C^{14}, the $C^{14}O_2$ produced was collected in KOH in the center well of Warburg vessels and counted as $BaC^{14}O_3$ at infinite thickness. The amount of hexose that was metabolized by way of the shunt pathway was calculated either from the TPN^+ reduction (*5*) or from the $C^{14}O_2$ production. Pentose phosphate formation was not used as a means of estimating the proportion of G-6-P metabolized by the shunt pathway because pentose intermediates are utilized by these enzyme extracts.

A typical experiment is described in the legend of Fig. 2. At the end of a 20-minute incubation period the disappearance of G-6-P was complete in the presence of added TPN^+ whether phosphate was present or not. However, as can be seen on the basis of the increase in absorption at 340 mμ (Fig. 2), the percentage of G-6-P metabolized by way of the shunt in the presence of 0.05*M* phosphate was only 55 percent of that in the presence of Tris. Also recorded in Fig. 2 are the parallel results obtained on the basis of $C^{14}O_2$ production from glucose-1-C^{14}.

A second series of experiments was carried out in a glycolysis medium (*6*) in the presence of either 0.02*M* Tris or 0.02*M* potassium phosphate buffer. Oxidized glutathione was added as an electron acceptor for TPNH (*7*). Under these conditions it was not necessary to add TPN^+ to the incubation mixtures and there was an 85 percent inhibition of $C^{14}O_2$ formation from 0.5 μmole of glucose-1-C^{14} in the phosphate buffer. Lactate was formed in both the Tris and phosphate buffers but was radioactive only in the latter. With glucose-6-C^{14} the lactate was radioactive in both buffers and no $C^{14}O_2$ was formed. These results are in agreement with the view that the glucose is being degraded through both the glycolytic and shunt pathways.

The relative contributions of these two pathways of glucose metabolism in various tissues have been the subject of numerous publications (*8*). Certainly the availability of TPN^+ in the cell may limit glucose oxidation through the

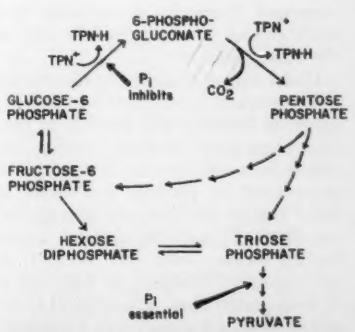

Fig. 1. Phosphate effects on pathways of carbohydrate metabolism.

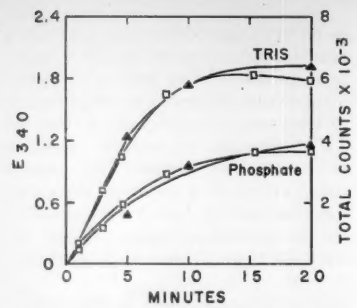

Fig. 2. Inhibition of the shunt in phosphate buffer as measured by TPN reduction and $C^{14}O_2$ formation from glucose-1-C^{14}. For the TPN reduction, reactions were carried out in duplicate vessels either in 0.05*M* Tris buffer, *p*H 7.4, plus 0.09*M* KCl, or in 0.05*M* potassium phosphate buffer, *p*H 7.4. Experimental vessels contained 0.5 μmole of G-6-P, 1.3 μmole of TPN^+, 5.0 μmole of ATP, and 10 μmole of $MgCl_2$ in a final volume of 3.0 ml. In control vessels either G-6-P or TPN^+ was omitted. The reaction was started by addition of 0.2 ml of an enzyme extract prepared as described in the text. The increase in optical density at 340 mμ was followed in a Beckman model DU spectrophotometer at room temperature. For the $C^{14}O_2$ production experimental vessels contained 0.5 μmole of glucose-1-C^{14} instead of 0.5 μmole of G-6-P; otherwise the reactants were the same. Open squares represent optical density at 340 mμ. Solid triangles indicate $C^{14}O_2$ production.

shunt. In intact ascites cells, for example, very little glucose is oxidized by way of this pathway (*9, 10*), most of it proceeding via glycolysis. We have found, however, that with extracts of these cells, the addition of an excess of TPN^+ or of a TPNH electron acceptor allows essentially all of the glucose to follow the shunt route. Methylene blue (*9, 10*) and pyruvate (*10*) have been found to stimulate the direct oxidation of glucose in intact ascites cells, presumably by acting as electron acceptors for TPNH. We have also found that oxidized glutathione will stimulate the shunt pathway in intact cells. These findings certainly implicate the availability of TPN^+ as an important factor in determining how much glucose is metabolized by way of the shunt pathway.

Under our experimental conditions the P_i concentration of the medium has been shown to influence the pathway of glucose breakdown in tissue extracts. It should be noted that the level of phosphate used to produce this effect is about four to ten times the average intracellular P_i concentration of intact Ehrlich ascites tumor cells (*11*). It is not surprising, however, to find that a P_i level greater than physiological is required to alter the pathways. Generally, in experiments designed to test cofactor requirements in cell-free systems, it is necessary to add a higher concentration of cofactor than is actually present in the intact cell. In order to test the effect observed in these studies under more physiological conditions we are at present attempting to devise means of varying the intracellular P_i concentration. It is clear, however, that no matter what the physiological effect of P_i turns out to be, in attempts to compare the relative contributions of the glycolytic and shunt pathways in glucose metabolism (at least in cell free systems), the P_i concentration of the medium should be carefully controlled (*12*).

EDWARD A. KRAVITZ*
ARMAND J. GUARINO
Department of Biological Chemistry, University of Michigan, Ann Arbor

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On the Role of the Vagus in the Control of Aldosterone Secretion

Abstract. Aldosterone in adrenal venous blood of dogs is increased by constriction and decreased by release of constriction of the inferior vena cava. Section of the cervical vagi did not affect the rise of aldosterone but prevented its fall. The receptors for stimuli to increases of aldosterone secretion may not be the same as those for stimuli to decreases.

Although there is evidence that the control of aldosterone secretion depends in part upon a function of intravascular volume (*1*), no mechanism has been proposed whereby stimuli from volume changes can be transmitted to the adrenal cortex. In view of the known modification of vagal impulses by changes in intrathoracic blood volume (*2*), we sought to determine whether the vagus plays a role in the control of aldosterone secretion.

Acute experiments were carried out in normal dogs anesthetized with Nembutal. Cannulas were placed in the lumbo-adrenal vein (*3*), and blood from the adrenal was collected intermittently for determination of aldosterone. To avoid stimulation of aldosterone secretion by blood loss per se, blood was infused at the rate at which it was lost. Radioactive (C^{14}) cortisone was added to the plasma, which was then extracted with dichloromethane. The dried extract was chromatographed on the following three systems: (i) chloroform:hexane:formamide:water (90:10:5:5); (ii) toluene; methanol:water (10:7:3); (iii) toluene: ethyl acetate:methanol:water (9:1:5:5). The cortisone-plus-aldosterone zone of (i) and (ii) was eluted for transfer to the next system. Aldosterone was determined by measuring soda fluorescence on paper in a fluorimeter (*4*) and corrected for losses as indicated by the C^{14} count on (iii). The mean recovery was 53 ± 10 percent (standard deviation). No other adrenal steroid which produces soda fluorescence has been found to run with aldosterone after passage through these three systems.

Aldosterone secretion was stimulated by constriction of the inferior vena cava above the diaphragm (*5*) by means of an inflatable cuff so as to raise the femoral venous pressure by 10 cm of water. The hemodynamic effects of caval constriction were estimated, in all experiments, from continuous tracings of brachial arterial, right atrial, and femoral venous pressures on a Sanborn 150 eight-channel recorder and from intermittent determinations of hematocrit.

In some experiments the vagi were sectioned; this was done at the level of the thyroid cartilage.

Figure 1*a* shows the results of a "control" experiment, in which constriction was applied twice and released once. By 60 minutes after caval constriction, aldosterone secretion had risen, and by 90 minutes after release of the constriction it had fallen. The temporal relationships were found to be highly reproducible, and these time intervals were used in all subsequent experiments where rises or falls of aldosterone secretion were under investigation.

Table 1*A* shows the effects of caval constriction on 13 occasions; Table 1*C*, the effect of release of constriction on five occasions. Effects of constriction in increasing, and of release of constriction in decreasing, aldosterone secretion are highly significant ($p < .001$ for both effects).

After vagal section, caval constriction was as effective in increasing aldosterone secretion as it was when the vagi were

Table 1. Effect of caval constriction and vagal section on aldosterone secretion (μg/hr). The mean, plus or minus standard deviation, is given at the bottom of each column.

A. Vagi intact		*B.* Vagi cut		*C.* Vagi intact		*D.* Vagi cut			*E.* Vagal section alone			
							Release			Time after section (min)		
Contr.	Constr.	Contr.	Constr.	Constr.	Release	Constr.	90 min	150 min	Contr.	60	150	210
1.8	8.0	6.9	15.1	8.0	3.3	4.3*	7.4		5.0	5.7	2.8	4.2
3.3	13.6	0.4	10.3	7.6	2.3	10.4	3.4	8.3	9.0	9.3	10.0	11.6
3.1	7.6	2.7	11.9	11.4	3.4	11.9	9.3		3.6	3.0	2.3	2.3
2.5	7.2	5.0	14.0	6.0	4.6	14.0	20.0		0.4	5.3		
6.9	11.4	4.1	9.6	20.0	13.7	9.5*	7.7	10.9	2.7	6.3		
3.4	7.9	3.0	11.0			9.6	7.9		5.0	3.3		
2.6	4.3					11.0	9.5		4.1	7.4		
2.5	7.2								3.0	4.9		
1.2	4.3											
3.0	10.4											
5.8	9.5											
1.3	6.0											
5.3	20.0											
3.28 ± 1.73	9.03 ± 4.22	3.68 ± 2.32	11.98 ± 2.16	10.6 ± 5.43	5.5 ± 4.64	10.10 ± 2.79	9.31 ± 4.74		4.10 ± 2.47	5.65 ± 2.05		
($p < .001$)		($p < .001$)		($p < .001$)		($p > .5$)			($p > .5$)			

* Vagi sectioned immediately before release.

intact. Figure 1*b* shows an experiment in which caval constriction was performed after vagal section. Table 1*B* gives the results of six such experiments. The effect of constriction in increasing aldosterone secretion is again highly significant ($p < .001$).

Whereas vagal section did not prevent a rise in aldosterone secretion following caval constriction, it did prevent a fall in aldosterone secretion following release of constriction. Figure 1*b* shows an experiment in which release of constriction was performed after vagal section. Table 1*D* gives the results of seven such experiments. There was no significant effect on aldosterone secretion ($p > .5$). The return to control levels of femoral venous pressure and of brachial arterial and right atrial mean and pulse pressures, and of the hematocrit, showed that release of constriction was as effective in reversing the hemodynamic effects of caval constriction in these experiments as it was in those in which the vagi were intact.

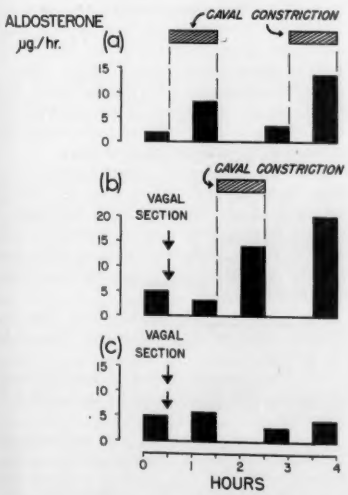

Fig. 1. Aldosterone from adrenal vein blood of dogs: (*a*) during constriction and release of inferior vena cava; (*b*) during constriction and release of inferior vena cava after vagal section; (*c*) following vagal section alone.

In two experiments (Table 1*D*) the constriction was applied with the vagi intact, and the vagi were sectioned immediately prior to release of constriction. A fall in aldosterone was prevented, as in the other experiments in this group. In two experiments, after 150 minutes there was still no tendency for the aldosterone to fall (Table 1*D*).

Vagal section alone (without caval constriction) was without consistent effect on aldosterone secretion, as shown by the results of the experiments reported in Table 1*E*.

These experiments confirm a report that caval constriction above the diaphragm raises aldosterone secretion (*5*) and show that this phenomenon is readily reproducible within 1 hour. The increase of aldosterone secretion so produced *does not* depend upon the integrity of the vagus nerve.

These experiments demonstrate, furthermore, that release of caval constriction lowers aldosterone secretion to control levels, and they show that this phenomenon is readily reproducible within 90 minutes. The effect on aldosterone secretion of release of caval constriction, as estimated from these experiments, *does* depend upon the integrity of the vagus nerve.

The findings cannot be explained by assuming a constant stimulus to increased aldosterone secretion, with ultimate control depending upon inhibitory vagal impulses. If this were the case, vagal section alone should have led to increases of aldosterone secretion.

The tracings of hemodynamic events and hematocrit values showed return to control conditions within 1 hour after release of caval constriction, whether the vagi were sectioned or not. If these parameters reflect the effective stimuli to aldosterone secretion, then it appears that the pathways mediating stimuli which lead to increases of aldosterone secretion may be different from those mediating stimuli which lead to decreases. The latter are dependent upon the integrity of the vagus; nothing is known about the former.

These experiments throw no direct light on the possible role of the diencephalon in mediating control of aldosterone secretion (*6*). They do supply data consistent with such a hypothesis in providing a pathway whereby "volume" stimuli may reach the central nervous system.

The results suggest that the concept of a single "volume receptor" for body-fluid volume (*7*) is an oversimplification. The stimuli that signalize expansion of effective body-fluid volume may well depend upon receptors other than those that mediate the stimuli which signalize contraction of effective volume.

IVOR H. MILLS*
ALFRED CASPER
FREDERIC C. BARTTER
Section on Clinical Endocrinology,
National Heart Institute,
Bethesda, Maryland

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Abstracts of Papers Presented at the Autumn Meeting, 6–8 November 1958, University of California, Berkeley

Some Effects of Substituting the Deoxyribonucleic Acid of Isolated Nuclei with Other Polyelectrolytes

The addition of large, negatively charged molecules to isolated cell nuclei which have been depleted of their deoxyribonucleic acid (DNA) restores much of the biochemical activity of the nucleus.

Up to 75 percent of the deoxyribonucleic acid of isolated thymocyte nuclei can be removed by incubation with pancreatic deoxyribonuclease (DNAase). Nuclei so depleted of their DNA lose their capacity for adenosine triphosphate (ATP) synthesis, for amino acid incorporation into protein, and for adenosine uptake in nuclear ribonucleic acids.

If polyanions are added at the time the DNA is removed, one can substitute for more than two-thirds of the DNA without any apparent loss of activity. The polyanions tested include other DNA's, ribonucleic acids, and polyadenylic acid, and *non-nucleotides* such as polyethylene sulfonate, heparin, and chondroitin sulfate. Added polycations, such as protamine or polylysine, do not restore function to DNAase-treated nuclei. Moreover, polylysine, when added to nuclei whose DNA is still intact, greatly inhibits amino acid uptake into nuclear protein.

The findings suggest a correlation between negative charge and the biochemical activity of the nucleus.

V. G. Allfrey, A. E. Mirsky
Rockefeller Institute

New Coenzyme Containing Pseudovitamin B_{12}

Cell-free extracts of *Clostridium tetanomorphum* decompose L-glutamate by the following sequence of reversible reactions:

$$\text{Glutamate} \overset{\text{I}}{\rightleftarrows} \beta\text{-methylaspartate} \overset{\text{II}}{\rightleftarrows} \text{mesaconate} \overset{\text{III}}{\rightleftarrows} \text{citramalate} \overset{\text{IV}}{\rightleftarrows} \text{pyruvate} + \text{acetate}$$

The rate of reaction I in the forward direction can be measured by coupling it with reaction II and measuring the rate of mesaconate formation spectrophotometrically. Reaction I, which involves the interconversion of straight- and branched-chain C_5 structures, has been shown to require a coenzyme that can be removed from the cell-free extract by adsorption on charcoal. The coenzyme has been purified by ion-exchange methods and found to be a yellow-orange compound with high activity in the enzymatic assay system. The coenzyme is rapidly inactivated by visible light, which also causes a striking change in its absorption spectrum. The light-inactivated coenzyme is red and possesses an absorption spectrum similar to that of vitamin B_{12}. In the presence of KCN the spectrum of the coenzyme is virtually identical with that of vitamin B_{12} except in the far ultraviolet. The coenzyme contains cobalt, cyanide, ribose, phosphate, and adenine, known components of pseudovitamin B_{12}. It also contains one or more additional adenine-containing moieties which are readily split off by exposure to light and appear to be essential for coenzyme activity.

H. A. Barker, H. Weissbach, R. D. Smyth
University of California, Berkeley

Effect of Deuterium Oxide on Biological Systems

The price of deuterium oxide (heavy water) has fallen to a fraction of its former value, making possible more extensive investigation into the biological effects of this substance than had been possible after it first became available 20 years ago.

Different isotopes of an element do not possess identical chemical and biochemical properties, and these differences can be expected to be very large between hydrogen and deuterium because of their large mass difference. Important effects on the structure of biologically significant macromolecules are to be expected. The effects of a deuterium environment on the growth, reproduction, and metabolism of algae, tumor cells, *Drosophila,* and mice have been studied.

Environmental D_2O concentrations in excess of 30 to 40 percent appear to be toxic or to inhibit the growth of the alga *Chlorella,* mice, and *Drosophila.* By serial subculture, algae can be adapted to grow well in D_2O concentrations up to about 60 percent. Unadapted cells form giant cells at high D_2O concentrations due to a failure to divide.

Mice (strain C_{57}) maintained on 25 and 30 percent D_2O in their drinking water and inoculated with Ehrlich's ascites tumor cells showed an increase in survival time of about 50 percent compared with control mice inoculated but maintained on ordinary water.

Heavy water decreases the fertility of mice. The effect is more pronounced in male mice, and recent studies have shown that the development of the spermatozoa is impaired. When the mice have been maintained on 30 percent D_2O for 4 or more weeks, many sperm appear by microscopic examination to be morphologically defective.

The development of *Drosophila* is inhibited by D_2O in the media. Experiments are in progress to investigate possible mutagenic effects of D_2O.

This work was sponsored by the U.S. Atomic Energy Commission.

Edward L. Bennett, O. Holm-Hansen, A. M. Hughes, K. Lonberg-Holm, V. Moses, B. M. Tolbert
University of California, Berkeley

Thermodynamic Properties of a Biological Steady-State System as Represented by the Carbon Reduction Cycle in Photosynthesis

The biochemical pathway of carbon reduction during photosynthesis in green unicellular algae has been traced by allowing these organisms to photosynthesize in the presence of $C^{14}O_2$ and subsequently analyzing the C^{14}-labeled compounds thus formed. This metabolic pathway, in part cyclic, lends itself particularly well to studies of the thermodynamic properties of the biological steady-state as an interesting case of the chemical steady-state. The suitability of this system to such studies stems from several factors.

1) The metabolic pathway is to a considerable extent isolated from other metabolic pathways of the cell by the chloroplast membrane and by the fact that the net rates of conversion of the carbon reduction cycle are much greater than the rates of other interacting pathways.

2) The primary reactants (water, carbon dioxide, and light) can be easily maintained at constant levels, regardless of the rate or duration of reaction, and two of these (light and carbon dioxide) can be varied easily to control the rate of reaction.

3) The rate of the reaction can be readily observed without interfering with the system.

4) The concentrations of the intermediates may be determined by means of C^{14} labeling.

The concentrations of intermediates at measured rates of photosynthesis have been determined and used to test the validity of some equations of the thermodynamic steady-state at certain points in the carbon reduction cycle.

This work was sponsored by the U.S. Atomic Energy Commission.

J. A. Bassham
University of California, Berkeley

Effect of Light on the Bioelectric Potential of Nitella

Illumination of one end of *Nitella clavata* cells at first produces no change of potential, but if illumination is continued for about an hour, the light end becomes more and more negative, eventually reaching a value of 50 to 60 mv negative to the darkened end. There is quick recovery on darkening, sometimes with an overshoot to above normal, and the effect can now be repeated almost indefinitely on successive light exposures. The change actually consists of a decreased positive potential at the illuminated end (as is shown by killing the other end, or by inserting a microcapillary contact into the sap). It appears to be photosynthetically mediated, for red light is as effective as blue. It is not, however, enhanced by increased CO_2 content of the water, hence is probably not due to accumulation of photosynthetic products. Indeed, 2 percent CO_2 rather effectively abolishes the light effect.

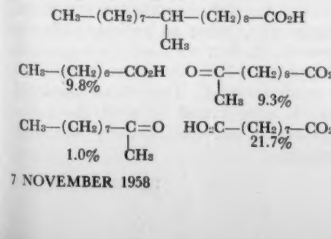
The light effect is greatest when distilled water bathes the cells and is decreased by added salts, especially by KCl. Even one or two stimulations of the cell also decreases the light effect, probably because of the exit of KCl from the sap. It is suggested that the light effects are due to movements of potassium within the cell, either from cytoplasm to vacuole or vice versa, depending upon the postulated site of the membrane potential (at tonoplast or plasma membrane). This is in agreement with results obtained in other organisms which show increased potassium uptake in the light.

LAWRENCE R. BLINKS
DORIS M. CHAMBERS
Hopkins Marine Station, Stanford University

Location of a Branch in a Saturated Carbon Chain

In degradation of natural products, location of a branch in a saturated carbon chain has been traditionally troublesome because of lack of sufficient selectivity in attack at the tertiary carbon. The advent of gas-phase chromatography has rendered possible the detection of such small amounts of material that identification of low yields of degradation products arising from attack at the tertiary carbon becomes feasible if a reaction can be used which gives these products in larger yields than products arising from other positions along the chain. Oxidation with chromic acid in acetic acid solution has been found to be quite satisfactory for this purpose.

A representative degradation is that of 10-methyloctadecanoic acid, which has yielded the indicated products (yields in percentage by weight).



Either the products on the left *or those* on the right fully establish the structure of the acid. Since quantities of 0.01 mg may be readily detected by gas chromatography, the degradation may be applied reliably to samples as small as 5 mg, even in instances where the oxidation is only one-fifth as satisfactory as that cited. In the several branched acids examined, the ketone has usually been the degradation product recovered in lowest yields, which have been in the range of 0.2 to 3.2 percent. The method has failed entirely only for a 4-methyl acid, in which there appears to be no significant selectivity of oxidation at the tertiary carbon. The largest amount of secondary degradation product which has been encountered was no more than 20 percent of the amount of primary product.

JAMES CASON
JOAN FEARING FESSENDEN
University of California, Berkeley

Satellite Orbits

Let (r, θ, ϕ) be spherical coordinates describing the position of a satellite relative to the earth: r is radial distance from the center of the earth to the center of the satellite, θ is colatitude, and ϕ is longitude. Assume that the only forces on the satellite are those due to the earth's gravitational potential V. Assume V to be of the form $V = V^0 + JV^2$, where J is the oblateness parameter and V^0 is the potential for a spherical (uniform density) earth [see Blitzer, Weisfeld, Wheelon, "Perturbations of a satellite's orbit due to the earth's oblateness," *J. Appl. Phys.* **27**, 1141 (1956)]. For an initial position x^0 and initial velocity v^0 let $r = r(t, x^0, v^0, J)$ be the radial distance of the satellite. Let $R(x^0, v^0, J)$ = maximum over all t of $r(t, x^0, v^0, J)$. For orbits which do not pass over the poles or lie in the equatorial plane it is shown that $R(x^0, v^0, J)$ is a discontinuous function of J. The discontinuity occurs at $J = 0$, it is a simple jump, and the size of the jump is given. If one describes the motion as that of a point on a moving ellipse, the standard expressions for the rotation of this plane (at nearly constant inclination about the north-south pole axis) and the rotation of the ellipse in this plane are derived. The jump enters in that the eccentricity of this ellipse undergoes a slow periodic variation of period proportional to $(1/J)$, but the amplitude depends only on initial conditions.

STEPHEN P. DILIBERTO
University of California, Berkeley

Climatic Significance of Marine Invertebrates during Later Geologic Time

The broad distribution of modern shallow-water marine invertebrate faunas is controlled to a major degree by temperature. Fossil faunas are considered to have been similarly controlled. The distribution and relationships of fossil marine faunas when compared with those of living faunas indicate that the continents and geographic poles were in their present positions during the Tertiary and strongly militates against changed positions during the Paleozoic and Mesozoic. Fossils closely related to organisms now living occur in the late Mesozoic and Tertiary and form the basis for direct inferences about the distribution of temperature zones during these intervals.

The low- and middle-latitude occurrences of warm-water marine faunas during the late Mesozoic and early Tertiary indicate that the tropics (in terms of temperature) then extended above the middle latitudes. Subsequently the tropics were restricted toward the equator until the time of maximum glaciation during the Pleistocene, with later expansion to their present area. The early Mesozoic and Paleozoic marine faunas have distribution patterns similar to those of the Tertiary and Recent, indicating the presence of comparable temperature zones. Analysis of the faunas indicates that during most of this time the tropics were as widespread as those of the early Tertiary, although there was at least one major glaciation (late Paleozoic).

In summary, during the Paleozoic, Mesozoic and Tertiary, it appears that the tropical zone was usually much more widespread than now, and that restricted tropics, including those of the present time, are abnormal.

J. WYATT DURHAM
University of California, Berkeley

Size of Pores and Their Contents in Sieve Elements of Dicotyledons

Comparative structure and cytophysiology of sieve elements suggest that the strands connecting the protoplasts of contiguous elements through pores in sieve areas play an important role in translocation of food in the phloem. The pores and their contents—that is, the connecting strands and the callose cylinders encasing the strands—were measured in 150 species of some 60 families of dicotyledons. The diameters of the pores ranged in different species from a fraction of a micron to about 14 μ. Typically, in the same species, the pores were larger in the sieve areas of the sieve plates (end walls bearing comparatively highly differentiated sieve areas) than in those in the side walls. The pores and the connecting strands of the sieve plates were larger, and the differences in dimensions between the pores and the strands of the sieve plates and those in the side walls were greater, in elements with simple sieve plates than in those with compound sieve plates. Whether the sieve plates are simple or compound, sample measurements indicate a wide variation in ratio between total pore area per sieve plate and transverse area of sieve element; this ratio tends to be greater in elements with compound sieve plates.

KATHERINE ESAU
VERNON I. CHEADLE
University of California, Davis

Enzymatic Conversion of Uridine Diphosphate D-Glucuronic Acid to Uridine Diphosphate Galacturonic Acid, Uridine Diphosphate Pentose, and Xylose Polysaccharide

Sugar nucleotides have been shown to be important precursors in the formation of the various complex saccharides in animal, microbial, and plant cells.

The results obtained by several investigators working with intact plants and plant tissue slices indicated that the D-xylose and L-arabinose constituent units of pentosans originate from uronic acid precursors by a loss of the sixth carbon atom. However, the mechanism of formation of these compounds has not been known.

We now have evidence that particulate preparations from *Phaseolus aureus* (mung bean) seedlings are capable of catalyzing the formation of uridine diphosphate galacturonic acid and uridine diphosphate pentose from uridine diphosphate D-glucuronic acid. It thus appears that the mung bean particulate preparations contain a 4-epimerase capable of converting uridine diphosphate D-glucuronic acid to uridine diphosphate galacturonic acid, and another enzyme (or enzymes), decarboxylase, which decarboxylates the uridine diphosphate uronic acid (or acids) to uridine diphosphate pentose (or pentoses).

Particulate preparations from asparagus shoots, radish roots and leaves, and spinach leaves are also found to catalyze these reactions.

There is evidence that preparations from asparagus and other plants contain an enzyme system that can catalyze the transfer of xylose from uridine diphosphate xylose to β-1,4-linked xylo-oligosaccharides, ranging in degree of polymerization from 2 to 5, to produce the next higher member of the same xylo-oligosaccharide series. There is an indication that a polysaccharide, xylan, is also formed from UDP xylose by preparations from the same plants.

D. S. Feingold, E. F. Neufeld, W. Z. Hassid
University of California, Berkeley

Low-Frequency Propagation in the Ionosphere

The electromagnetic field produced by a low-frequency vertical electric dipole is expressed as a sum of modes traveling in the "leaky" waveguide formed by the perfectly conducting earth and the imperfectly conducting ionosphere. An analysis of the field shows that the long-distance propagation of radio waves depends on either the first or the zeroth order mode, depending on whether the ratio of the height of the ionosphere to the free-space wavelength is greater or less than $3^{-\frac{1}{2}}$. The problem of numbering the modes is considered, and it is found that in all proposed schemes there is a possibility of ambiguity in numbering.

Bernard Friedman
University of California, Berkeley

Lower Jurassic (Toarcian) Flora from the West Coast of Vancouver Island

Plant-bearing strata have been discovered in a small sea-coast section consisting of calcareous shale, siltstone, sandstone, and tuff on the remote western coast of Vancouver Island. The plant-bearing section is underlain and overlain by beds containing marine faunas. The association of the flora with faunas substantiates the age determination based on an independent study of the plants. Petrifactions of the rachises of several genera, preserved as compressions, are of interest because of the rareness of such fossilization combinations. The flora is predominantly cycadeoid. *Ptilophyllum, Pterophyllum, Otozamites, Matonidium, Dictyophyllum,* and *Nilssonia* are the dominant elements. Conifers are rare. The various species of these genera appear to have remarkably close affinities with those of the early Jurassic floras of Mexico, Alaska, Japan, Korea, and elsewhere where floras of this age are recognized. The discovery of this locality eliminates a geographic gap between the flora in northern North America and Asia and those of the Pacific region and Mexico. There is every likelihood that extensive floras of a reasonably uniform composition existed on the fringes of the northern and western Pacific land areas during early Jurassic time.

Wayne L. Fry
University of California, Berkeley

Development of a High-Field Magnet

The design and arrangements for the safe operation of a kerosene-cooled, iron-free, solenoid magnet for continuous operation at fields in the 100,000-gauss range will be described.

The objective has been to have a relatively large working space, with the best attainable homogeneity, and maintenance of the current distribution patterns at all fields during a series of experimental observations over the range zero to maximum field. The construction details will be illustrated by slides and a visit to the Low Temperature Laboratory of the University of California, where the magnet was developed, is scheduled.

The Office of Naval Research, the Atomic Energy Commission and the National Science Foundation have contributed to the magnet development.

W. F. Giauque, D. N. Lyon
University of California, Berkeley

Scattering of High-Energy Electrons by Deuterons

The bombardment of deuterium by high-energy electrons often results in disintegration of the deuteron. In this paper, using a simple model of the deuteron, we have calculated the number of electrons scattered at various angles and the energy loss after such a reaction. This model assumes that the electrons interact with each nucleon independently of the other through their electromagnetic fields (impulse approximation). The probability that an electron scatters into a given angle and energy range is then the sum of the probability due to the proton alone and that due to the neutron alone.

The proton and neutron are considered as extended bodies with distributions of charge and magnetic moment, and with a distribution of momenta. The results depend significantly on the neutron structure, which is not well known. We have computed the pattern of scattered electrons for several different neutron distributions and compared them with the results of other more precise and lengthier calculations. These results agree, indicating that the above-described model of the deuteron is valid. Extensive computations have also been made for comparison with experiment.

This work was supported in part by the U.S. Air Force through the Air Force Office of Scientific Research.

A. Goldberg
Stanford University

On the Exponents of a Simple Compact Lie Group

Finding what remains invariant under a group of transformations is a classical problem in mathematics. One such problem which has attracted considerable attention is as follows: If G is a simple, closed, continuous group (simple compact Lie group), what can one say about the polynomials in the infinitesimal generators of G which remain invariant under the transformation $x \rightarrow b \times b^{-1}$ of G itself for all b in G. Much of the early work on this question was done by the mathematician Casimir and the physicist Racah. One knows that all such polynomials are generated by a finite number of primitive polynomials, the degrees of which, $m_1, m_2, \ldots m_r$ are called the exponents of G. A surprising turn came when, in 1950, C. Chevalley, at the International Congress in Cambridge, showed that the invariant symmetric theory in the infinitesmal generators is essentially the same as the antisymmetric theory. This meant one could determine the exponents from the Betti numbers of G. In fact, as a consequence, the Poincaré polynomial of G is just

$$(1 + t^{2m_1-1})(1 + t^{2m_2-1}) \ldots (1 + t^{2m_r-1}).$$

Upon learning from Chevalley what the exponents were in special cases, H. Coxeter came upon a remarkable coincidence. He was able to read these numbers off directly from the eigen values a particular transformation in a finite reflection group (Weyl group) associated with G. No explanation for this phenomenon was given. Subsequently, using an entirely different approach, R. Bott obtained the exponents by applying Morse theory to a study of the geodesics on G. Thus three unrelated methods were found to yield the exponents of G, and one of them was only empirical.

Here we announce a direct proof of the equivalence of these methods. Principally we establish the validity of the method of Coxeter. (In doing so we settle certain questions on finite reflection groups.) The major step is to relate the observations of Coxeter with the proof of Bott. The link between these two is played by the principal three-dimensional simple subgroup, a subgroup discovered (and used for other purposes) simultaneously by Dynkin and de Siebenthal.

BERTRAM KOSTANT
University of California, Berkeley

Occurrence of Aluminum Hydride Emission in Spectra of Long-Period Variables

In the vicinity of minimum light, the long-period variables χ Cygni and R Cygni show an intense emission-line spectrum, of which a prominent constituent is the $A^1\Pi - X^1\Sigma^+$ system of the aluminum hydride molecule. The AlH spectrum is not complete, but occurs only as short series of rotational lines in each band branch; this has been explained as due to the formation of AlH molecules by inverse predissociation. It is known that some long-period variables show no AlH emission, and the present investigation was designed to discover the rules of its occurrence. The spectra of some 70 long-period variables have now been observed near minimum light with low dispersion at the Crossley reflector. An intense display of AlH emission has been found in just eight of these stars. The conclusions are:

1) The AlH phenomenon occurs strongly only in S-type variables. It has been observed in no stars of period shorter than 370 days, but all those of period longer than this value show AlH emission near minimum light.

2) The intensity of the AlH lines does not seem to depend upon whether the star is a marginal or an advanced S type, upon its light amplitude, or upon any other obvious characteristic.

3) Although AlH emission appears weakly in a few M-type variables, no occurrence of comparable intensity with that in the S stars has been observed among the pure M types.

GEORGE H. HERBIG
Lick Observatory

Individual Differences in Susceptibility to Hypnosis

While it is well known that among cooperative subjects some are much more readily hypnotizable than others, there is little firm knowledge about the distribution of susceptibility within the population or about the personality correlates of susceptibility.

The susceptibility of 74 subjects has been studied by attempting to hypnotize them individually by a standard procedure. Because the subjects volunteered for another kind of experiment, the bias introduced by their volunteering for an experiment in hypnosis has been avoided. Results for these subjects are compared with results from a sample of 200 subjects tested by others at the University of Michigan. The measures of susceptibility prove to be highly consistent internally, and preliminary work with another sample shows them to have satisfactory retest reliability.

The form of the curve of distribution of susceptibility fluctuates with the items entering into the scale of measurement and with the relative weights assigned. In view of the high intercorrelation of many of these items, a bimodal curve results if the scale is limited to these items.

Preliminary to preparing a personality inventory that will predict susceptibility to hypnosis, the subjects scoring high and low in the susceptibility experiment have been interviewed by a psychiatrist. At least one syndrome emerges: The highly susceptible men are predominantly well-adjusted, outgoing students, identified with their successful fathers, and capable of assuming both the role of leader and the role of follower.

ERNEST R. HILGARD
Stanford University

Biological Implications of Abortive Reproduction of Animal Viruses

The reproduction of swine influenza virus, like that of influenza A, influenza B, and mumps viruses, yields a high proportion of infective particles when the number of particles inoculated is less than 0.2 per cell. When the number is greater than 2 per cell, more than 95 percent of the particles produced are noninfective. Reproduction that leads to the production of noninfective virus particles may be designated abortive.

With each of the four viruses, the proportion of new particles that are noninfective increases progressively as the number of particles inoculated is increased beyond 2 per cell. Initial particle-cell ratios of 20 lead to the production of virus particles 99 percent or more of which are noninfective. Abortive reproduction is not related to the instability of the infective property of the virus particle. Although influenza A, influenza B, and mumps viruses are highly unstable, swine influenza virus has an infective half-life of about 22 hours at 35°C.

Regardless of the number of particles inoculated, the reproduction of mumps and the three influenza viruses leads eventually to the production of new particles in numbers that greatly exceed those necessary for the induction of abortive reproduction. This results in a relation which has the aspects of a feedback mechanism; the larger the number of virus particles that are produced the smaller is the proportion that are infective. Under these conditions, the reproductive process cannot perpetuate itself and the infection leads to a spontaneous cure.

FRANK L. HORSFALL, JR.
Rockefeller Institute

Metallic Conduction of Nonmetals at High Pressures

There are two possible mechanisms by which a nonmetal may be converted into a metal under the influence of high pressures. First, under the influence of high pressure, the kinetic energy of the electrons can be increased until it is greater than the binding energy. Second, the band theory predicts that if the valence bond intersects the conduction bond a metal must result. The pressures required by the former appear to be greater than those presently available for a laboratory experiment. Electronic transitions have been reported by Bridgeman for cesium, cerium, tellurium, and silver sulfide. Alder and Christian have reported that a number of solids become conducting at high pressures obtained by shock waves.

In these experiments the resistance was determined as a function of pressure. At pressures of 160,000 atm the maximum specific resistances of phosphorus and silver oxide had a value of 600×10^{-6} ohm cm. Certain measurements indicate that the value may be as low as 20×10^{-6} ohm cm. The most likely value is 100×10^{-6} ohm cm. This conductivity is somewhat better than that of bismuth at atmospheric pressure. These data strongly indicate that both phosphorus and silver oxide have become metallic at these pressures. At present the gap in phosphorus is being studied as a function of pressure.

The behavior of iodine has been studied to a pressure of 200,000 atm. At atmospheric pressure the specific resistance of iodine is above 10^{30} ohm cm. This is reduced to 10^{-2} ohm cm at the highest pressure that we have studied. The resistance is still decreasing with pressure. Unless there is a phase transition, iodine will become metallic at room temperature at a pressure on the order of 400,000 atm.

GEORGE JURA, HAROLD STROMBERG, ROBERT E. HARRIS, RIMUS J. VAISNYS
University of California, Berkeley
Radiation Laboratory, Livermore

Kinetic Isotope Effect Involving Methyl Radicals

The complete set of eight reactions of the type

$$x_3C + y - z \rightarrow x_3C - y - z \rightarrow x_3Cy + z$$

(where x, y, and z are permuted between H and D) has been studied experimentally by Whittle and Steacie [*J. Chem. Phys.* **21**, 993 (1953)] over a range of temperature. The six-atom activated complex with an axis of threefold symmetry is sufficiently simple to permit a complete vibrational analysis. This complete analysis has been used to find a suitable equivalent four-atom complex. For a single set of force constants, deduced from considerations of molecular structure and molecular spectroscopy, a complete set of frequencies for eight activated complexes was computed, the mass along the reaction coordinate was found, and the kinetic isotope effect was evaluated by Bigeleisen's formulation of the activated complex

theory. Except for certain small trends, believed to correspond to internal inconsistencies in the experimental data, there is satisfactory agreement between theory and experiment for 18 different ratios of rate constants between 403° and 563°K.

HAROLD S. JOHNSTON
University of California, Berkeley

Brain Chemistry and Adaptive Behavior in the Rat

In a continuing study of the relations between adaptive behavior and brain chemistry, we have tested several strains of rats in various learning situations. On all learning tasks, the S_1 strain (descendants of Tryon's maze-bright animals) is superior to the S_8 strain (descendants of the Tryon's maze-dull animals).

The S_1 rats are also found to have significantly greater cholinesterase (ChE) activity than the S_8 rats in both cortical and subcortical brain. This difference may be specific to ChE, since in other enzymes tested no strain differences appear.

To determine whether the observed relationship between ChE and learning capacity might be merely fortuitous, several genetic experiments were undertaken. First, a cross between the S_1 and the S_8 strains (the K strain) was tested on standard learning problems, and individual performance records were compared with individual ChE activity levels. Second, through selective breeding, two lines of rats high in ChE, and two lines low in ChE (the R strains), were developed. We have now begun behavioral tests of these animals.

The results of the tests with the K and R rats indicate that while ChE is definitely related to learning ability, the relationship is not a simple linear one.

On the basis of the data, a hypothesis is suggested which relates learning capacity to the acetylcholine-cholinesterase balance in the central nervous system. Proposals for further empirical checks of this hypothesis are then discussed.

DAVID KRECH
MARK R. ROSENZWEIG
EDWARD L. BENNETT
University of California, Berkeley

Radiation in High-Energy Electron-Proton Collisions

The radiation of a photon is one of the dominant processes competing with the production of a π-meson when a high-energy electron loses energy in a collision with a proton. The energy and angular distributions of the scattered electron, as observed by experiments at Stanford, are affected by both processes. The meson production process is of prime interest since it depends sensitively on neutron structure. However, an accurate determination of the radiation process is necessary to facilitate this investigation of the neutron's size.

Our calculation endeavors to provide this theoretical knowledge of the scattering contribution resulting from the radiative process by employing the well-known formalism of quantum electrodynamics. Our standard treatment of the dynamical effects of proton recoil employs fewer approximations than earlier calculations, and the effect of recently acquired knowledge of the proton's charge and magnetic-moment structure is also included. Certain higher orders of approximation, involving multiple photon processes and meson interactions, have not been considered, but are estimated to limit the accuracy of our result by about 5 percent at the highest energies in the range of interest. Our results, except for small deviations at lower energies, are in substantial agreement with earlier calculations.

This work was supported in part by the U.S. Air Force through the Air Force Office of Scientific Research.

C. N. LINDNER
R. A. BERG
Stanford University

Quantitative Tests of the 120-Inch Mirror of Lick Observatory

During the final stages of the figuring process, the 120-inch mirror was tested in the telescope on stars. Quantitative Hartmann tests were carried out in addition to standard knife-edge tests. The latter were made by D. O. Hendrix, who was in charge of figuring the mirror.

Instead of the conventional tests by zones [J. Hartmann, *Z. Instrumentenk.* **24**, 1, 33, 97 (1904)], local and detailed departures of the mirror from a paraboloid were determined. Originally only radial profiles were derived, but it was found that in the presence of appreciable astigmatism and local errors, a common zero-level for different radial profiles could not be established. A more elaborate procedure had to be developed by supplementing the conventional radial measurements with tangential ones.

Measurements of the 192 images of holes in the Hartmann screen gave 384 equations of condition, from which normal equations were formed for determination of the best-fitting paraboloid. The extrafocal image of the Hartmann screen, as formed by this paraboloid, was then computed and compared with the measured one, and radial as well as tangential deflections in the focal plane were derived from the comparison. Integration of these deflections yielded radial and tangential profiles of the departures of the mirror surface from an ideal paraboloid. The closed tangential profiles permitted establishment of a common zero-level for all the profiles. After the latter were reconciled, it was possible to draw a contour-map of the mirror. A rapid improvement in the mirror figure resulted from the availability of this detailed information to the opticians. The mirror is now free from astigmatism, and its figure compares favorably with those of the best large telescope mirrors.

N. U. MAYALL
S. VASILEVSKIS
Lick Observatory

Production and Reproduction of the Mitotic Apparatus

The isolation of the mitotic apparatus (MA) in analyzable quantities from synchronously dividing cells (sea urchin eggs) has made it possible to put certain questions concerning the physiology of mitosis in chemical terms. Analyses of the MA as isolated by our earlier methods have yielded the following general facts. (i) The fully formed MA, according to the data of Mazia and Roslansky, comprises 10 percent or more of all the protein in the cells studied. (ii) By electrophoretic and ultracentrifugal criteria, the MA is composed largely of a single species of protein, but a second component, larger and more negatively charged, is always found in smaller quantities. (iii) The major component is a protein of average molecular weight about 315,000 (data of A. M. Zimmerman). (iv) Ribonucleic acid (RNA) is always present. Recent analyses by A. M. Zimmerman give an RNA content of 6 percent and show the presence of all four nucleotides of RNA. (v) Evidence from solubility studies as well as from observations with certain mitotic inhibitors suggests that S—S bonds (or other bonds involving thiol groups) are involved in the protein-to-protein linkages by which the mitotic apparatus is assembled.

In the living cell, the MA is a highly unstable structure, and all earlier attempts to isolate it directly from living cells have failed. The hypothesis that the coherence of the MA depends on S—S bonds predicts that it may be stable only when these are "protected." Such stabilization might be achieved, reversibly, in the presence of another S—S system. On the basis of this prediction, a successful method of isolation of the MA directly from living, dividing sea urchin eggs has been developed recently in collaboration with J. M. Mitchison, H. Medina, R. Iverson, and P. Harris. The isolation is made directly in isotonic dextrose containing dithiodiglycol. The "native" MA so isolated is stable only in the presence of dithiodiglycol. Its properties are under study.

The characterization of the proteins of the MA has permitted an approach to the question whether the substance of which it is composed is a new species synthesized as the MA forms or whether it exists before division and is merely assembled as mitosis proceeds. In experiments by H. A. Went, antibodies to the extractable proteins of the unfertilized egg and to the isolated mitotic apparatus were prepared, and the Ouchterlony gel-diffusion technique was employed to determine whether the unfertilized egg contained an antigen identical with that characteristic of the protein of the mitotic apparatus. The MA yielded a single antigen which matched one of the several antigens of the eggs extracted before division. These results favor the hypothesis that the proteins of the MA are preformed before division and are assembled at division.

The evidence of a decisive role of S—S bonds in the formation of the MA predicts that an excess of a nontoxic —SH compound capable of penetrating the cell

readily should block mitosis reversibly. In studies with mercaptoethanol this prediction was verified. However, if cells were blocked until the time when the next division was expected normally, and the block was then reversed, they divided directly into four cells. Apparently the reproduction of the mitotic apparatus, based on the reproduction of the centers, proceeds even when it cannot function.

DANIEL MAZIA
University of California, Berkeley

On the Stellar Population of the Nuclear Region of the Galaxy

Spectrograms of integrated starlight in four regions near the nucleus of the Galaxy have been obtained recently at the McDonald Observatory. These indicate that the principal contributors to the light of the nuclear region are stars of solar and later type. The general stellar population by luminosity of the nuclear region is therefore different from that of the globular clusters of the Galactic halo.

A comparison of the Galactic nuclear region with that of the Andromeda nebula suggests a probable large-scale structural difference, although the two systems are of the same general class.

W. W. MORGAN
University of Chicago

Atomic Beam Research on Radioactive Atoms

The fundamental purpose of the research is the measurement of the spin, magnetic dipole, and electric quadrupole moment of radioactive nuclei whose half lives lie in the range 20 minutes to 25,000 years. The results are of particular importance in the field of nuclear structure, for most nuclei lie in this range and many of them lie far from the line of stability. The total number of such nuclei treated at Berkeley is approximately 60.

A number of very difficult problems had to be solved, mostly related to the very small number of atoms, as low as 10^{10}, that could be manufactured. These problems involved developments in the atomic beam equipment itself, isotope production at the cyclotron, radiochemistry suitable for beam work, beam collection techniques, and special counting techniques. As an example, x-ray counters were developed that yielded an over-all efficiency of about 40 percent with a background as low as 0.3 count/min.

The first measurements were made on the neutron-deficient isotopes of rubidium and cesium and were soon extended to thallium, indium, silver, gold, copper, and other elements whose atoms are characterized by an electronic angular momentum of 1/2. This is the situation of maximum signal intensity. Quadrupole moments of atoms in this ground state are not susceptible to measurement, and parallel research was undertaken on the radiohalogens whose electronic ground state has an angular momentum of 3/2. A considerable number of isotopes of bromine and iodine have been measured, including Br^{76}, which is the first observed case of hyperfine levels that are not in the normal order. Astatine (211) has been a successful special case of the halogens.

Another important result of these techniques is the determination of the electronic characteristics of the atoms in those cases where there was insufficient prior information on this point. In this connection, there has been particular success in the case of the heavy elements, such as protactinium, neptunium, plutonium, americium, and curium, where the spectroscopic ground state characteristics have been determined as well as the nuclear properties.

The senior members of the group associated with this research are J. C. Hubbs, E. Lipworth, H. A. Shugart, and H. A. Silsbee.

W. A. NIERENBERG
University of California, Berkeley

Mechanisms for Dehydration

The role of β-hydroxy ketones and β-hydroxy acids in organic synthesis is well known. We have undertaken a study of the rate of dehydration in aqueous acid for representative members of these classes of compounds.

The rate of formation of substituted cinnamic acids from β-aryl-β-hydroxypropionic acids is very sensitive to the substituent in the aromatic ring. The reaction is strongly acid-catalyzed.

Quite in contrast, the dehydration of β-aryl-β-hydroxybutanones shows little sensitivity to variations in structure. The rate of dehydration shows a lesser sensitivity to acid concentration, which parallels the rate of enolization of simple ketones.

The consideration of these results and others previously reported provides very strong evidence for the operation of two mechanisms of dehydration in each series of compounds. Rate-determining enolization is the usual mechanism for dehydration of β-hydroxy ketones; suitable compounds undergo dehydration via a carbonium ion mechanism. For β-hydroxy acids, a carbonium ion mechanism is observed in most cases; suitable compounds appear to undergo dehydration via enolization.

D. S. NOYCE, P. A. KING, W. L. REED
University of California, Berkeley

Infrared Detection of the Free Radical NH_2

In earlier work the photolysis of hydrazoic acid suspended in solid nitrogen, argon, and xenon at 20°K revealed spectral features certainly associated with unstable intermediate species which react upon diffusion [E. D. Becker, G. C. Pimentel, M. Van Thiel, *J. Chem. Phys.* 26, 145 (1957)]. The present work is directed toward the critical test of the proposed explanation that NH_2 was formed by the reactions

$$HN_3 + h\nu \rightarrow NH + N_2 \quad (1)$$
$$NH + HN_3 \rightarrow NH_2 + N_3 \quad (2)$$
$$NH_2 + HN_3 \rightarrow NH_3 + N_3 \quad (3)$$

and that NH_2 was detected by the infrared absorption of its bending mode at 1290 cm^{-1}.

Hydrogen bonding by HN_3 provides a possible explanation of the observed absorptions alternative to the assignment to free radicals. Hydrogen bond formation of the type $HN_3 \cdots HN_3$ and also with ammonia, $H_3N \cdots HN_3$, was studied, and in each case the hydrogen bond causes spectral changes. These changes do not, however, account for the new features which are obtained when HN_3 is photolyzed in solid nitrogen.

A second critical test of the proposed interpretation relates to the effect of concentration of hydrazoic acid in the matrix. At lower concentration the production of ammonia through reaction 3 should be inhibited relative to reaction 2. An experiment was performed at the lowest concentration experimentally feasible. Photolysis again produced the spectral features of ammonia and showed distinctly the reduction of diffusional processes. The formation of the band at 1290 cm^{-1} was apparently not affected.

The most informative test of the proposed identification of NH_2 is the preparation of the deuterated counterparts. For this purpose DN_3 was prepared and photolyzed. The absorption at 1290 cm^{-1} was not produced, but new absorptions were observed at lower frequencies appropriately shifted to be assigned to NHD and ND_2.

In summary, all of the experiments performed substantiate the conclusion that the NH_2 radical has been detected for the first time by infrared absorption.

GEORGE C. PIMENTEL
MATHIAS VAN THIEL
University of California, Berkeley

Diurnal Cycles of Man and Animals

Little is known about diurnal cycles of man except for the waking-sleeping cycle of day and night. The results of recent studies made in this and other laboratories on animals kept in constant light or darkness, or after blinding or destruction of visual mechanisms of the brain, may throw light on the factors underlying the diurnal cycle of man.

The rat lends itself well for these studies since continuous records can readily be obtained of its spontaneous activity (by means of a revolving drum) and food and water intake.

The rat is nocturnal and usually starts its one daily more or less continuous period of activity shortly after the onset of darkness and ends it shortly before dawn. After enucleation or occipital lobectomy each rat may show its own internal cycle of diurnal activity—that is, its one daily period of activity may begin earlier each day by as much as 60 minutes, or later each day by as much as 40 minutes. This

means that, with successive days or weeks, the daily period of activity may start during the day or even extend over the entire day, while in the dark the rat is completely inactive. One rat after enucleation has now for many months begun to run earlier each day by almost exactly 26 minutes regardless of the noise and other disturbances caused by other rats and by laboratory workers.

The length of the diurnal cycle is independent of the effects of treatment with various drugs and external conditions, especially temperature, but it can apparently be influenced by unknown cosmic agents, by removal of the olfactory bulbs, and by thyroxin.

These observations on the rat and other animals may throw light on the diurnal cycle as seen in man under pathological as well as normal conditions. They may help, for instance, to explain the mystery of the inverted sleeping-waking rhythm of some patients with lethargic encephalitis.

CURT P. RICHTER
Johns Hopkins Hospital

Contributions toward the More Accurate Calculation of Atomic Properties

For atoms with more than one electron it has not been possible to solve exactly the quantum mechanical equations of motion. Various perturbation and variation techniques are available to help in the search for accurate approximations to the wave functions. The most widely and successfully used approach is the Ritz variational method which gives the most accurate approximation to the energy of the system. However, as has been long recognized, the approximate wave function derived by this method may be relatively inaccurate for the computation of other properties of the system. By a particular application of the well-known perturbation theory we have found a method for improving these calculations which requires only moderate computational effort. The general prescription presented is of a formal nature, yet solutions have been found for a number of problems based on the simple one-electron atom. From this starting point good calculations of several properties of the two-electron atom have been carried out, and further applications are being attempted.

This work was supported in part by the U.S. Air Force through the Air Force Office of Scientific Research.

CHARLES SCHWARTZ
Stanford University

Differential Mitotic Response of Diploid and Polyploid Nuclei to Auxin and Kinetin Treatment

During the course of tissue differentiation in pea roots, chromosome doubling is the usual concomitant of cellular maturation. Polyploid nuclei resulting from endomitotic reduplication divide infrequently and in such cells differentiation leading to mature cell types proceeds. In experiments on the intitiation of callus tissues from excised segments of mature pea root tissues, it was found that the occurrence of mitoses in either diploid or polyploid nuclei in the tissues was dependent upon the constituents of the nutrient medium provided. On a yeast extract-auxin medium, tetraploid mitoses predominate, although infrequent mitotic figures of diploid, octaploid, and higher ploidy level also occur. On a synthetic medium containing the auxin, 2,4-D, but in which yeast extract is replaced by a known mixture of vitamins and organic nitrogen sources, only diploid mitoses are found, although cells with polyploid nuclei are known to occur in the tissues.

A study has been made to determine the factors in the yeast extract-auxin medium, but lacking from the synthetic medium, which stimulate mitoses in cells with polyploid nuclei. Additions of nucleic acid constituents were made to the synthetic medium on which mature root tissue segments were cultivated, and Feulgen squashes for cytological study were prepared periodically. Yeast nucleic acid and individual purines and pyrimidines tested were ineffective in inducing mitoses in polyploid nuclei. Kinetin (6-furfuryl amino purine), when it is added to the synthetic medium at $5 \times 10^{-6} M$, initiates frequent mitoses in tetraploid nuclei which otherwise would remain in the resting state. Thus, in diploid and polyploid cells of the same tissue system, physiological differences of considerable importance to cell differentiation are demonstrable.

JOHN G. TORREY
University of California, Berkeley

Certain Aspects of the Biology of Mouse Runways

Through the use of automatic, repeating photographic recorders the traffic in natural runways of mice in the wild has been investigated. During 19 months 8495 passages of 27 species of vertebrates were recorded, mostly meadow mice (*Microtus californicus*) and harvest mice (*Reithrodontomys megalotis*). The average was 11 passages per runway per 24 hours.

Meadow mice provided an average of 7.8 passages per 24 hours and a maximum of 67. During weekly periods the average number of meadow mice using a runway was about six. Single individuals passed along a runway as many as 45 times in one day. Male meadow mice provided more passages per individual than females did. The average duration of excursions from underground retreats out into runways and back was 5 minutes. Daytime excursions were longer than those at night, and excursions by females lasted longer than those by males.

Traffic in the runways was not noticeably greater when the general population of meadow mice was high than when it was low. It appears that the population increases by multiplication of occupied runway systems rather than by an increase in the number of individuals in runways already occupied. In this manner the population can increase many fold without causing a great increase in the number of contacts between individuals. This is relevant to the question of the natural control of populations by the frequency of contacts and the consequent "stress."

OLIVER P. PEARSON
University of California, Berkeley

Application of Digital Computers to the Reduction and Analysis of High-Dispersion Molecular Spectra

The reduction and analysis of the rotational fine structures of highly resolved molecular band spectra involve several very laborious and time-consuming operations, even when the spectra are relatively simple in structure. Among these operations are the calculation of the vacuum wave numbers from the line measurements and the identification of the branches into which the component lines of individual bands may be divided. The latter step becomes very difficult, if not impossible, if the spectra are complex, with severe overlapping of bands.

Programs have been developed for the I.B.M. 701 computer on the Berkeley campus by which both of the operations mentioned above may be carried out automatically. Since, in general, the molecular constants determining the band structures are unknown, the program of analysis makes use of the fact that the locations of lines within any particular branch correspond approximately to a second-order equation, so that two successive lines can be found with a wave-number difference which is close to any arbitrarily chosen wave-number interval. The computer searches for all branches satisfying second-order equations with coefficients lying within arbitrarily chosen ranges.

The programs have been successfully tested on a sequence of bands of the Swan system of the C_2 molecule and on a complex region of the TiO spectrum between 6200 and 6500 A.

JOHN G. PHILLIPS
University of California, Berkeley

Adrenal Hypercorticalism in Spawning Pacific Salmon

Death of all the Pacific salmon shortly after their first spawning presents a problem of unusual interest since this is an almost unique phenomenon among vertebrates (the phenomenon is unknown in mammals and is rare in fishes).

Histological studies of the various organs and tissues of the spawning salmon revealed markedly increased functional activity of the pituitary gland during the maturation of the gonads, followed at spawning by degeneration. At the same time the adrenal cortical tissue exhibited pronounced hyperplasia. Widespread atrophy and degeneration was found among other organs: stomach, liver, spleen, gonads, thyroid, and vascular system. Studies of the blood plasma revealed a high concentration of catabolic adrenal

corticosteroids, 3 to 7 times that present normally in sea salmon. Associated with the increase in circulating adrenal steroids were hyperglycemia, lowered plasma proteins, reduced gamma globulin concentration, and disappearance of lymphocytes from the spleen. Such findings are consistent with adrenal hypercorticalism.

It has been possible to produce in immature rainbow trout, by means of hydrocortisone implanted in cholesterol pellets, almost all the degenerative changes characteristic of the spawning salmon. All the fish so treated died in 3 to 4 weeks. There are striking similarities between the clinical and pathological findings in the spawning salmon and Cushing's syndrome in man.

O. H. ROBERTSON
Stanford University

New Mechanism of Temperature Adaptation in Plants

In earlier work on the effects of temperature on tomato plants, it was found that the relatively low optimal temperature for growth and fruit set is due to an interaction between a temperature effect with a Q_{10} of 2 to 3 on growth processes and one with a Q_{10} of about 0.8 on sugar translocation.

After it was established that for optimal growth of tomato (both in length and in weight) and other plants, the plants should be subjected to a succession of light and darkness on a 24-hour cycle basis, the optimal length of this cycle was determined at different constant temperatures. A large number of individual experiments unequivocally show that at the optimal range of temperature for growth (20°C) the optimal cycle length is 24 hours, but at 15°C it is about 28 hours, and at 30°C it is 18 hours. Therefore, the cycle length for optimal tomato growth has a Q_{10} of 1.25. Practically the same value for Q_{10} was found for nyctinastic movements of *Phaseolus* leaves, growth of *Baeria chrysostoma*, and development of *Saint-paulia ionantha*.

F. W. WENT
Missouri Botanical Garden

New Method for Determination of Distances of Late-Type Stars

One of the fundamental problems of astronomy is the accurate determination of the distances of stars. Since the apparent brightness is relatively easy to measure, this problem is, in general, solved if the true, or intrinsic, luminosity can be found by some means. The classical method is the measurement of trigonometric parallax, but only for a relatively few nearby stars can this procedure yield accurate results. For a few groups, such as moving clusters, combinations of proper motion and radial velocity determinations give accurate distances. Spectroscopic methods, calibrated by the more fundamental ones, can give good average values but, except for main-sequence stars, individual determinations are often of rather low accuracy.

The great majority of stars of spectral type G0 and later show a bright reversal at the centers of the wide dark H and K lines of Ca II. It has been found that the widths of these emission features correlate with the absolute luminosities for all stars from dwarf M-type stars to the supergiants —that is, over a range of brightness of at least 15 magnitudes. At present, efforts are being made to test the accuracy attainable in this manner. The method is calibrated by using the sun and the four bright Hyades stars whose luminosities are known from cluster motions. Results obtained so far indicate that, by reducing observational error, absolute luminosities good to one- or two-tenths of a magnitude can be obtained. If this expectation is supported by further investigation, this procedure will have many valuable applications.

O. C. WILSON
Mount Wilson and Palomar Observatories

Gas-Liquid Partition Chromatography—Some Theoretical and Engineering Considerations

A theory of elution chromatography is proposed for the design of large-size chromatographic columns. In this theory, an equilibrium linear isotherm is assumed to be the mass-transfer mechanism, and dispersion of the solute band is attributed to longitudinal diffusion.

The theory was tested for elution of acetone, benzene, and toluene with helium in a small gas-liquid chromatographic column packed with 30- to 60-mesh fire brick containing a silicone oil. Tests were conducted at 100 lb/in.^{2} (gage) over a range of Reynolds numbers from 0.2 to 1.8. Although agreement between theory and experiment is not completely satisfactory, the results indicate that longitudinal dispersion may be a major cause of band spreading.

On the basis of the method a preliminary plant design and economic evaluation were made for production of ethyl benzene, zene, *m,p*-xylene and *o*-xylene from a hydrocarbon mixture.

C. R. WILKE
ROBERT H. HOUSTON
ANDREAS ACRIVOS
University of California, Berkeley

Physical Model of Nova Aquilae 1918

The position of a nova in the scheme of stellar evolution is briefly indicated. The nova mechanism provides for ejection of mass and, hence, permits a star to progress toward the final white dwarf stage. No satisfactory explanation of the nova mechanism exists; a study of the detailed pattern of ejection may give some clue to the nature of the mechanism.

Nova Aquilae 1918 provides an excellent case for a study of the details of the ejected shell. The observable structure of the spectral lines can be related to the physical structure of the shell. The shell consists of a series of rings, or, more precisely, of truncated cones of remarkable symmetry with respect to what may be termed the "poles" of the star. Light oscillations in the transition portion of the light curve are related to activity on the star alternating between the poles and the equator.

It may be shown that radiative excitation cannot account for all the phenomena observed in the spectral lines. Collisional excitation must play an important role in the production of the observed radiation.

HAROLD F. WEAVER
University of California, Berkeley

Gravitational Properties of Antimatter

A very precise series of experiments involving gravity was performed by Eötvös and collaborators between 1890 and 1922. These show, with an accuracy of about 1 part in 10^9, that the ratio of gravitational to inertial mass is the same for several substances scattered throughout the periodic table. A general discussion will be given of the inferences that can be drawn from these experiments in regard to the gravitational interactions of matter and antimatter, with and without the assumption that experiments performed in a hypothetical "antilaboratory" yield the same results as those performed in the laboratory. In particular, it will be shown that the Eötvös experiments preclude the possibility that the gravitational mass of a positron is equal to and opposite in sign from that of an electron. This conclusion follows from a consideration of the effect of the earth's gravitational field on the virtual positrons produced because of the polarization of the vacuum by the Coulomb field of an atom. If the total energy of the virtual positrons has anomalous gravitational properties, the difference between the gravitational and inertial masses of the atom is logarithmically divergent. If, on the other hand, only the positron rest mass is anomalous (not the kinetic energy), the mass difference is finite, and is 10 to 30 times larger than that permitted by the Eötvös experiments.

This work was supported in part by the U.S. Air Force through the Air Force Office of Scientific Research.

L. I. SCHIFF
Stanford University

Association Affairs

Preview of Programs at AAAS Washington Meeting

Some of the programs to be presented at the 1958 AAAS meeting in Washington are given here. Others will be announced in subsequent issues.

Mathematics

Section A. Vice-presidential address of Section A: "Pathology of Infinite Systems of Differential Equations," by Einar Hille, Yale University. Invited papers, cosponsored by the Operations Research Society of America: "Mathematics in the Social Sciences"; 27 Dec. Papers will be presented on mathematical organization theory (Merrill M. Flood, University of Michigan) and on psychological measurement and a theory of data (Clyde Coombs, University of Michigan).

Panel: "The Problem of Formulating a Problem," arranged by Richard S. Burington, Bureau of Ordnance, Navy Department, who will preside; 28 Dec. Papers: general considerations (Richard S. Burington); formulation of the problem of ballistic missile flight dynamics (J. D. Nicolaides, Bureau of Ordnance, Navy Department); the mathematician's point of view on formulating problems (Philip M. Whitman, Applied Physics Laboratory, Johns Hopkins University); the formulation of evaluation problems in systems-engineering analyses (D. C. May, Bureau of Ordnance, Navy Department); the formulation of nonlinear theories in fields and continua (Horace M. Trent, Naval Research Laboratory); determination of upper atmospheric properties from satellite observations (Robert Jastrow, Naval Research Laboratory); formulation of problems in geodesy (John O'Keefe, Army Map Service). Open discussion by members of the panel.

Association for Computing Machinery. Invited papers: "Adventures with Electronic Digital Computers"; arranged by a committee, J. H. Wegstein, National Bureau of Standards, chairman; 30 Dec.; William F. Cahill, National Bureau of Standards, presiding. Papers: French to English by computing machine (A. F. R. Brown, Georgetown University); musical compositions by a digital computer (Lejaran Hiller, University of Illinois); computers and the Dead Sea scrolls (Paul Tasman, IBM World Trade Corporation); Capital Airlines electronic reservation system (R. C. Douglas, Capital Airlines).

Physics

Section B. Three-session symposium, cosponsored by Sigma Pi Sigma and the Chesapeake Section of the American Association of Physics Teachers: "Reviews of Special Topics in Physics"; arranged by J. Howard McMillen, National Science Foundation; 28 and 29 Dec. Part I, Bernard B. Watson, Johns Hopkins University, presiding. Papers on lightning effects on trees and buildings (Francis M. Defandorf, National Bureau of Standards) and trends in cosmic ray research (Maurice M. Shapiro, Naval Research Laboratory). Part II, L. L. Marton, National Bureau of Standards, presiding. Paper on the properties of positronium (Richard A. Ferrell, University of Maryland). Part III, Edward J. Schremp, Naval Research Laboratory, presiding. Paper on the present status of relativity theory (Joseph Weber, University of Maryland).

Physicists' luncheon and vice-presidential address of Section B: "Science, Pseudoscience, and Parapsychology," by Raymond T. Birge, University of California; 29 Dec.; Robert Bruce Lindsay, Brown University, presiding.

American Astronautical Society. Guest lecture: "The Exploration of Space," by Hugh L. Dryden, National Aeronautics and Space Administration; 27 Dec. Technical session I: "Space Explorations"; 27 Dec. Paper on orbit decay and prediction of motion of artificial satellites (Herman F. Michielsen, Lockheed Missile Systems Division). American Astronautical Society Honors Night dinner; 27 Dec.; Ross Fleisig, Sperry Gyroscope Company, presiding. Technical session II: "Reentry Mechanics"; 28 Dec. Paper on heat transfer in high-speed slip flow (Richard A. Oman and Richard A. Scheuing, Grumman Aircraft Engineering Corporation). Technical session III: "Space Vehicle Design"; 29 Dec. Paper on the high-temperature research challenge in space vehicle design (Peter E. Glaser, Arthur D. Little, Inc.). Technical session IV: "Guidance, Control and Communications"; 30 Dec. Paper on simplified space guidance systems analysis (Curtis A. Brown and Ross Fleisig, Sperry Gyroscope Company).

American Meteorological Society. Invited papers: "Review of Recent Developments in Radar Meteorology"; arranged by Vaughn D. Rockney, U.S. Weather Bureau; 30 Dec. Papers on cloud physics and propagation (Walter (Hitschfeld, McGill University); synoptic meteorology (Edwin Kessler, III, U.S. Air Force Geophysics Research Directorate); severe storms and hurricanes (Myron G. H. Ligda, Stanford Research Institute); instrumentation and hydrology (Richard D. Tarble, U.S. Weather Bureau). Invited papers, cosponsored by the Association for Computing Machinery: "Numerical Weather Prediction"; arranged by George P. Cressman, National Meteorological Center, who will preside; 31 Dec.

Chemistry

Section C. Symposium: "Kinetics of Gas Phase Reactions"; 26 Dec.; Ralph Klein, National Bureau of Standards, presiding. Papers will be presented on the decomposition of vibrationally excited species (Basil de B. Darwent, Catholic University of America); chemically induced molecular excitation—the initial products of exothermic elementary reactions (David Garvin, Princeton University; kinetics of some reactions of atomic oxygen (Frederick Kaufman, Aberdeen Proving Ground); photo-oxidation mechanisms (Kenneth O. Kutschke, Canadian National Research Council); exploration of the elementary steps of diborane reactions (Rudolph A. Marcus, Polytechnic Institute of Brooklyn).

Two-session symposium: "Frozen Free Radicals"; 27 Dec.; F. O. Rice, Catholic University of America, presiding. Introduction (Julius Jackson, National Bureau of Standards); papers on electron spin resonance of certain free radicals (G. K. Fraenkel, Columbia University); electron spin resonance of polymers (R. E. Florin and D. W. Brown, National Bureau of Standards); the imine radical (W. B. Gager, National Bureau of Standards, and F. O. Rice); cold surface deposition of atoms from a molecular beam source (M. Scheer, National Bureau of Standards); small molecules (C. K. Jen and S. N. Foner, Johns Hopkins University); H atom reactions with solid olefins at low temperatures (R. Klein and M. Scheer, National Bureau of Standards); low-temperature x-ray diffraction investigations (L. H. Bolts, F. A. Mauer, and H. S. Peiser, National Bureau of Standards).

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Effects of High Energy Radiation"; 28 and 29 Dec.

Part I: "Small Molecules"; Leo A. Wall, National Bureau of Standards, presiding. Introductory remarks (Leo A. Wall); papers on characteristic features of radiation chemistry (Milton Burton, University of Notre Dame); the radiation chemistry of low molecular weight hydrocarbons (Leon Dorfman, Argonne National Laboratory); the effect of linear energy transfer on radiation chemical reactions (Robert Schuler, Mellon Institute); indirect and direct action of radiation on organic compounds containing the N-C bond (Warren M. Garrison, University of California).

Part II: "Polymers"; Milton Burton, University of Notre Dame, presiding. Papers on irradiation of polyethylene, IV: oxidation effects (H. Matsuo and Malcolm Dole, Northwestern University); the radiation-induced cis-trans isomerization of polybutadiene (Morton A. Golub, B. F. Goodrich Company); gamma irradiation of poly-α-methylatyrene (A. M. Kotliar, Naval Research Laboratory); radiation chemistry of polydimethylsiloxane (A. A. Miller, General Electric Company); gamma irradiation of fluorocarbon polymers (Roland E. Florin and Leo A. Wall, National Bureau of Standards); gamma irradiation of collagen (James Cassel, National Bureau of Standards).

Part III: "Irradiation Techniques"; S. David Bailey, Quartermaster Research and Development Command, presiding. Papers on irradiation-induced polymerization (Ed F. Degering, G. J. Caldarella, and M. A. Mancini, Quartermaster Research and Development Command); monitoring irradiation effects on monomers and polymers by mass spectrometry (Charles Merritt, Jr., Ed F. Degering, and Maurice L. Bazinet, Quartermaster Research and Development Command); irradiation of organic polymers in nuclear reactors (Oscar Sisman, Oak Ridge National Laboratory); competitive reagents and the radiolysis of glycine (Charles Maxwell, National Institutes of Health); low-temperature radiation studies (Daniel W. Brown and Leo A. Wall, National Bureau of Standards).

Contributed papers; 30 Dec. Part I, Gilbert W. Castellan, Catholic University of America, presiding. Papers on factors governing the deposition of suspensions by nonuniform electric fields (Herbert A. Pohl and James P. Schwar, Princeton University); the photolysis of acetone in perfluorocarbon solvents (Gilbert J. Mains, Carnegie Institute of Technology); strontium-90 balance in man (E. Lenhoff, H. Spencer, J. Samachson, and Arthur R. Schulert, Lamont Geological Observatory); ultraviolet absorption measurements of some aromatic compounds in solutions in the

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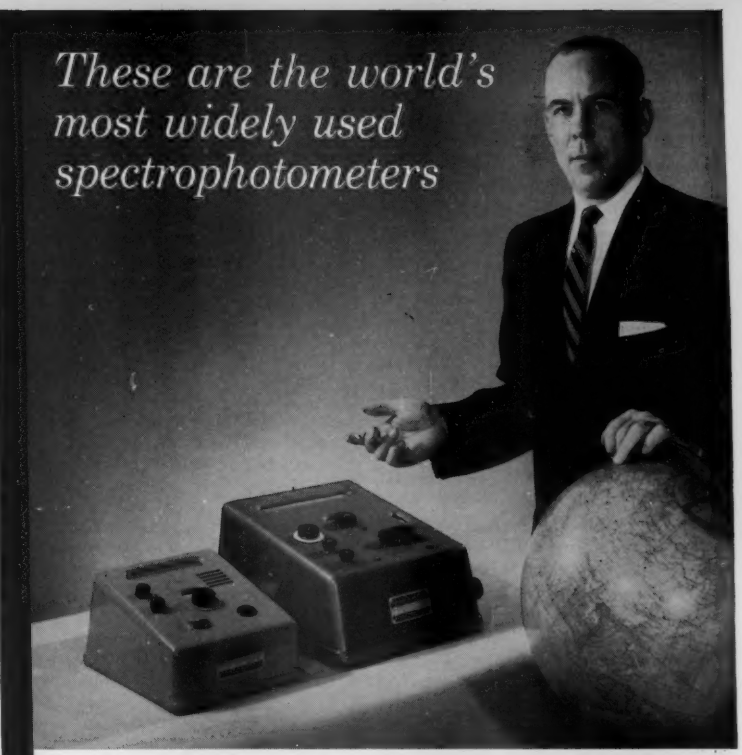
solid state (M. Ellen Dolores Lynch, Dunbarton College, Washington, D.C., and Columba Curren, Notre Dame University); ionization constants of derivatives of fluorene and other polycyclic compounds (Preston H. Grantham, Elizabeth K. Weisburger, and John H. Weisburger, National Institutes of Health); improved synthesis of amides (David W. Young and Eileen M. Paré, Sinclair Research Laboratories). Part II, George N. Kowkabany, Catholic University of America, presiding. Papers on a possible mechanism for respiratory chain phosphorylation (the pyridine nucleotide cycle) (Theodore I. Bieber, University of Mississippi); quantitative determination of adrenocortical steroids in the urine of pregnant women (David F. Johnson, Daniel François, and Erich Heftmann, National Institutes of Health); isolation of steroids from human feces (Erich Heftmann, Ekkehard Weiss, and Erich Mosettig, National Institutes of Health); activities of division of chemistry and chemical technology of the National Research Council (Clem O. Miller, National Research Council).

American Association of Clinical Chemists. Symposium: "Biochemical Studies in Schizophrenia"; moderated by Seymour S. Kety, National Institute of Mental Health; 29 Dec.; Elizabeth G. Frame, National Institutes of Health, presiding. Papers will be read on sources of error in biochemical research in schizophrenia (Seymour S. Kety); studies on ceruloplasmin and ascorbic acid in schizophrenia (Roger K. McDonald, National Institute of Mental Health); metabolism of epinephrine and norepinephrine (Julius Axelrod, National Institute of Mental Health); observations on catechol amines in blood and urine in mental illness (Hans Weil-Malherbe, National Institute of Mental Health); the significance of aromatic compounds in the urine of schizophrenics (Elwood H. LaBrosse, National Institute of Mental Health); some aspects of tryptophan metabolism in schizophrenia (Irwin J. Kopin, National Institute of Mental Health).

American Association of Clinical Chemists dinner; 29 Dec.; Oliver H. Gaebler, Edsel B. Ford Institute for Medical Research, presiding. Medical research observed in the Soviet Union (Thelma B. Dunn, National Cancer Institute).

Contributed papers; 30 Dec. Part I, Albert E. Sobel, Jewish Hospital of Brooklyn, presiding. Papers on chelated iron (Martin Rubin and J. V. Princiotto, Georgetown University Medical Center); effects of growth hormone and corticotropin on total output and partition of N^{15} from glycine, alanine, and ammonium citrate (O. H. Gaebler, Dorothy Kurrie, and Thomas Maska-



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leris, Edsel B. Ford Institute for Medical Research); the binding of amido black and bromphenol blue dyes by serum protein fractions separated by continuous-flow electrophoresis (F. William Sunderman, Jr., U.S. Naval Medical School, and F. W. Sunderman, Jefferson Medical College); determination of fibrinogen in plasma (Miriam Reiner and Helen L. Cheung, D.C. General Hospital); a simple method for determination of uropepsin or pepsin (Ernest C. Adams, Jr., Ray Mast, and Alfred H. Free, Miles-Ames Research Laboratory); stable starch substrate solution for the spectrophotometric determination of amylase (Eugene W. Rice, Presbyterian Hospital, Pittsburgh); the determination of organic acids in serum (Samuel Meites, Children's Hospital, Columbus, Ohio); photometric determination of the sialic (N-acetylneuraminic) acid distribution in cerebrospinal fluid (Abraham Saifer and Harold A. Siegel, Jewish Chronic Disease Hospital, Brooklyn). Part II, Joseph V. Princiotto, Georgetown University Medical Center, presiding. Papers on urinary excretion of aromatic metabolites in mental disease (Harry Goldenberg and Vivian Goldenberg, Hillside Hospital, Glen Oaks, New York); alterations in blood chemistry during iproniazid (Marsilid) hepatitis (Seymour Winsten and Lawrence Weiss, Albert Einstein Medical Center); detection of small amounts of phenothiazine-derived drugs by rapid urinary color tests (Irene S. Forrest and Fred M. Forrest, Veterans Administration Hospital, Brockton, Mass); choline reversal of anticholinesterase activity of psychotomimetic compounds in human serum (Herbert Sprince, Veterans Administration Hospital, Coatesville, Pa., and Irwin Lichtenstein, University of Pennsylvania); influence of lysergic acid diethylamide and vasotonic drugs on urinary excretion patterns (Harry Goldenberg, Vivian Goldenberg, and Arnold Blumberg, Hillside Hospital, Glen Oaks, New York); detection of the heterozygous carrier in galactosemia (David Yi-Yung Hsia, Irene Huang, and Grace Lawrence, Children's Memorial Hospital, Chicago, and Shirley G. Driscoll, Northwestern University Medical School); the adsorption of sulfonamides to blood protein precipitates (Harold L. Rosenthal, Washington University School of Dentistry, and Lois Jud, Rochester General Hospital); corticosterone and 17-hydroxycorticosterone levels in human plasma (Joseph McLaughlin, Jr., Edward C. Knoblock, and E. G. Herndon, Jr., Walter Reed Army Medical Center); the photometric determination of phenylpyruvic acid in urine (Abram Saifer and Alfred F. Harris, Jewish Chronic Disease Hospital, Brooklyn).

Astronomy

Section D. Vice-presidential address of Section D: "Surveying the Moon," Chester B. Watts, U.S. Naval Observatory; 26 Dec.; Dirk Brouwer, Yale University Observatory, presiding.

Astronomical League. Invited papers, cosponsored by Section D (Astronomy); arranged by Grace Scholz Spitz, Alexandria, Virginia, who will preside; 26 Dec. Papers will be read on achievements of amateurs in astronomy (James Q. Gant, George Washington University School of Medicine), nonastronomical achievements of amateur astronomers (Robert H. McCracken, Diamond Ordnance Fuse Laboratories), and opportunities and obligations of the amateur in science (Armand N. Spitz, Spitz Laboratories).

Insect Pathology and Biological Control

The first International Conference for Insect Pathology and Biological Control was held at the Hotel International in Prague, Czechoslovakia, 13–23 August. Approximately 150 delegates from 20 different countries attended. There were two delegates from the United States: John D. Briggs of the Illinois Natural History Survey and Edward A. Steinhaus of the University of California. The latter was assigned the role of spokesman for the Western nations, while I. A. Rubtzov of the U.S.S.R. lead the delegation of the Eastern countries. The conference was held under the auspices of the Czechoslovak and Slovak Academies of Sciences, with J. Weiser, head of the academy's Laboratory of Insect Pathology in Prague, and A. Huba, in charge of the Laboratory of Plant Protection in Ivanka, serving as host-chairmen of the meeting.

The conference opened with speeches of welcome by Ivan Málek, chief of the academy's Institute of Biology, and by Weiser and Huba. The scientific sessions and the presentation of scientific papers lasted through 16 August. The following ten sections (and their moderators) were convened: (i) Insect Bacteriology (E. A. Steinhaus), (ii) Insect Mycology (N. A. Telenga), (iii) Insect Helminthology (J. Weiser), (iv) Taxonomy of Entomophagous Insects (Z. Bouček), (v) Evaluation of the Results of Introductions of Entomophagous Insects (I. A. Rubtzov), (vi) Insect Virology (G. Bergold), (vii) Insect Protozoology (J. Weiser), (viii) Rise and Effect of Parasitic Insects (P. Mesnil), (ix) Use of Monophagous and Polyphagous Insects in Biological Control (Liu Chung Lo), (x) International Cooperation (J. Weiser and J. Huba).

A total of 65 papers were presented. Of this number, 36 were concerned with insect pathology and microbial control, 23 with entomophagous insects and biological control generally, and six dealt with the matter of international cooperation in the fields of insect pathology and biological control.

In addition to the strictly scientific parts of the conference, a sumptuous banquet was held the night of 14 August complete with appropriate toasts and gustatorial pleasures. Following the paper-reading sessions, there were several very enjoyable and greatly appreciated excursions. These included a trip through historical and modern Prague, a trip to Carlsbad and Marienbad to see some of the famous Czech spas, and an extended excursion to Slovakia, climaxed by a farewell dinner in the High-Tatras.

It is impossible to describe and to evaluate the conference in the space available here. Those interested in the subject matter of the conference are urged to write to the Czechoslovak Academy of Sciences in Prague. Complete proceedings of the conference will be published in early 1959. Notable advances were reported by representatives of almost every country present.

On the last day of scientific sessions conferences were held between the delegates of western and eastern European countries in an effort to establish better cooperation and liaison between these two areas and the individual countries concerned. Representatives (J. Franz and P. Bovey) of the Western European Commission Internationale de Lutte Biologique (CILB) explained their program and objectives. Delegates from eastern European and Asian nations formulated resolutions and statements of intent to form a somewhat similar organization among their countries. The hope was expressed that eventually closer liaison and cooperation could be established between the Eastern organization, the CILB, the Commonwealth Institute of Biological Control, and perhaps other groups.

Although regional meetings and conferences dealing with insect pathology and biological control have been held in several parts of the world, this is the first gathering of so large a group of scientists in these disciplines from so many countries. For this reason, this first international conference is of historic as well as of current scientific importance. The exceptionally fine and expertly managed facilities—including a radio-earphone interpreting system that provided simultaneous translations into Czech, German, English, and Russian—and the generous hospitality and solicitude of the Czech hosts, made the conference one that could be enjoyed from a human-relations as well as a scientific stand-

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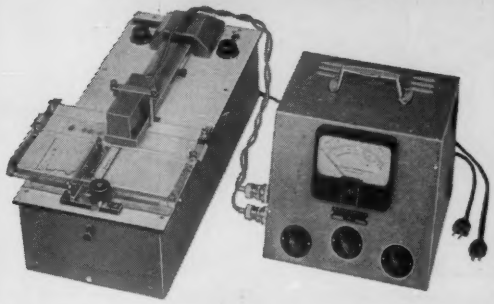

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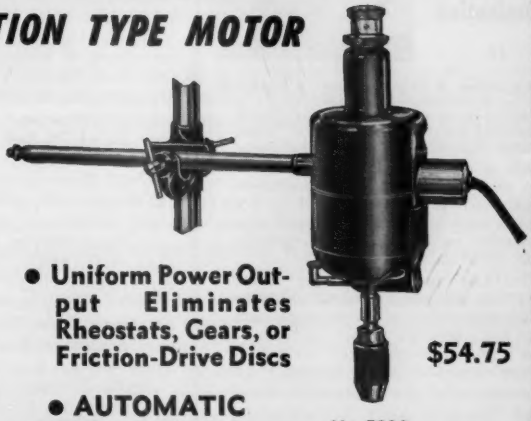

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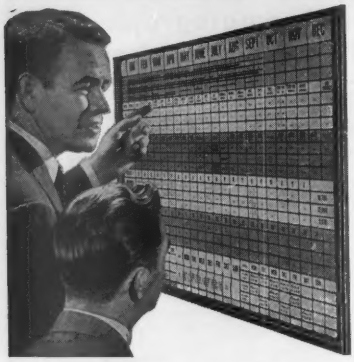

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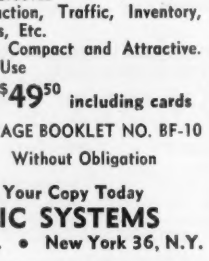

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point. Opportunity was provided for numerous small conferences and meetings, permitting valuable discussions and interchange of ideas and viewpoints. It was a conference that no one who was present is likely ever to forget, and it is to be hoped that the place and time of the second such conference may be decided soon.

Forthcoming Events

December

7–10. American Inst. of Chemical Engineers, annual, Cincinnati, Ohio. (F. J. Van Antwerpen, 25 W. 45 St., New York, N.Y.)

8–10. American Nuclear Soc., winter, Detroit, Mich. (ANS, P.O. Box 963, Oak Ridge, Tenn.)

9–10. Conference on Learning Effectiveness, Univ. of Pennsylvania, Philadelphia, Pa. (Air Force Office of Scientific Research, Air Research and Development Command, U.S. Air Force, Washington 25.)

10–16. American Acad. of Optometry, annual, Boston, Mass. (C. C. Koch, 1502 Foshay Tower, Minneapolis, Minn.)

12–13. Association for Research in Nervous and Mental Disease, annual, New York, N.Y. (R. J. Masselink, 700 W. 168 St., New York 32.)

15–17. American Soc. of Agricultural Engineers, winter, Chicago, Ill. (J. L. Butt, American Soc. of Agricultural Engineers, St. Joseph, Mich.)

15–19. Radiation Biology, 2nd Australian conf., Melbourne, Australia. (J. H. Martin, Physics Dept., Cancer Inst. Board, 483 St. Lonsdale St., Melbourne, Victoria.)

17. Institute of Aeronautical Sciences, Washington, D.C. (R. R. Dexter, IAS, 2 E. 64 St., New York 21.)

18–20. American Physical Soc., Los Angeles, Calif. (K. K. Darrow, APS, Columbia Univ., New York 27.)

26–31. American Assoc. for the Advancement of Science, annual, Washington, D.C. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5.)

27–29. American Economic Assoc., Chicago, Ill. (J. W. Bell, AEA, Northwestern Univ., Evanston, Ill.)

27–29. Econometric Soc., Chicago, Ill. (R. Ruggles, Box 1264 Yale Station, Yale Univ., New Haven, Conn.)

27–30. American Folklore Soc., New York, N.Y. (MacE. Leach, AFS, Univ. of Pennsylvania, Philadelphia, Pa.)

28–30. Archaeological Inst. of America, Cincinnati, Ohio. (L. A. Campbell, AIA, Dept. of Classics, Brooklyn College, Brooklyn, N.Y.)

29–30. National Council of Teachers of Mathematics, New York, N.Y. (M. H. Ahrendt, NCTM, 1201 16 St., NW, Washington 6.)

28–30. Western Soc. of Naturalists, Seattle, Wash. (J. P. Harville, San Jose State College, San Jose 14.)

(See issue of 17 October for comprehensive list)

Erratum: The American Rocket Society will meet in New York 17–21 Nov. 1958, and not 1–5 Dec. 1958.

Letters

Science Teaching

Many people will be interested in "1958 Parliament of Science," published in *Science* of 18 April [**127**, 852 (1958)], reporting the Washington, D.C., convention of the parliament on 15–17 Mar. 1958, conducted by the American Association for the Advancement of Science. However, the problems and recommendations must be supplemented by a practical program for the achievement of the aims and must reach those who have power to put the recommendations into effective practice, or the parliament has substantially failed.

Recommendations 51 through 55 stress the need to increase the subject-matter knowledge of people who are now teaching science and who propose to teach science. This can be accomplished in two ways: (i) Existing teachers must be given the credit which leads to higher salary if they take subject-matter courses in the liberal arts departments; (ii) prospective teachers must be permitted to substitute liberal arts courses for the education department courses presently required for certification. These reforms involve changes in university management and changes in the various state regulations, and both changes must be accomplished through political rather than scientific channels.

Recommendation No. 55 is the masterpiece of understatement in the whole report: "We believe that in many cases it is possible to reduce the number of hours in professional education courses required for certification or graduation, and that the corresponding increase in opportunity for other courses would improve teaching effectiveness." Every educated person knows that the world's great teachers, from Buddha, Aristotle, and Jesus Christ down to include most of our finest contemporary teachers, never had *any* courses in an education department.

We need a drastic reduction in the number of hours in professional education courses required for teacher certification or graduation. Science departments, not education departments, should select science teachers! A science-department teaching recommendation should be accepted legally as a substitute for, and in lieu of, education department courses. It is certainly not in the public interest that capable scientists, including even the President's science adviser, should be barred from teaching in the public schools by legal requirements imposed through the political influence of those less competent to judge qualifications of a science teacher.

A first step in improving science education and teaching is to get rid of the

arbitrary regulations which prevent the use of the potential talent we have. This will be difficult if not impossible under present conditions. The professional educationists now have political control of (i) the curriculum (what shall be taught) and (ii) teacher certification (who shall teach it). Published articles by educationists indicate that efforts to reduce this control will be resisted.

The United States education problem is too big to depend on the efforts of only one department (the education department) of the universities. The policy-making level and control must be widened to include representatives of all departments of American education—all university departments and all the learned professions. The narrow and limited background of the education department alone (or of any other single department) is inadequate. This plan has been tried and found wanting; yet California teachers wishing to improve their status encountered the following situation at the University of California (Los Angeles) summer session for 1958, as set forth in the official catalog: Department of education and physical education, 70 faculty members, 102 courses; department of physics, 6 faculty members, 14 courses; department of mathematics, 7 faculty members, 20 courses; department of chemistry, 8 faculty members, 11 courses. It is clear, here, that mere money and salary increases alone will not further the parliament's aims regarding improving science teaching. The education department would get ten times as much money as the mathematics department—and with no improvement in the teaching of mathematics.

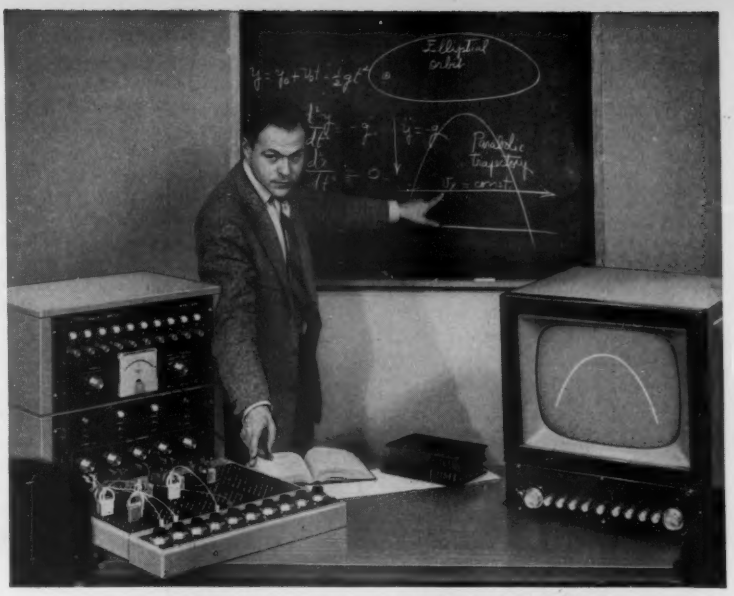
The situation calls for a realistic, practical, and aggressive program by the American Association for the Advancement of Science, directed toward informing the public and appropriate officials that (in most states) the education department courses required for high-school teaching credentials are unnecessary and excessive and that the maintenance of such requirements is an obstruction to improved science education and teaching.

WILLIAM W. PORTER II

Los Angeles, California

Too Many Authors

A letter from Z. I. Kertesz [*Science* **128**, 610 (1958)] deplores references which use *"et al."* after the first author's name, particularly when more than three authors are involved. There is cogent argument that, for anything short of a monographic treatment, the indication of more than three authors is not justifiable, in general. In fact, minor contributors should be listed—and their spe-



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A letter outlining specific areas of interest addressed to Dr. V. B. Corey, Technical Director, Donner Scientific Company, Concord, California, will bring full details. Dept. 5011.

cific contributions shown—in the acknowledgments.

A particular report comes to mind that appeared under merely one author's name. It describes the properties of a rare mineral which had not been adequately characterized or previously reported from localities outside of Russia. This article was written by a mineralogist who used data obtained by a chemist (analytical determinations), a physicist (electron micrographs), and two spectroscopists (minor components).

This six-page article might have had five authors, but the fact remains that the over-all responsibility for evaluating the data depended upon a single individual, the mineralogist.

In many instances the only justification for the use of more than three authors' names seems to be the accumulation of bibliographical credit for minor contributions. This situation, if abused—and it has been—can readily become ridiculous. It is discouraged, to some extent, by the use of *"et al."* in citing papers that are overloaded with authors.

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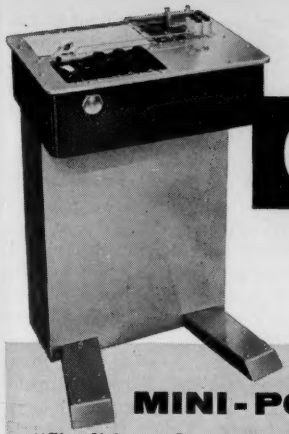

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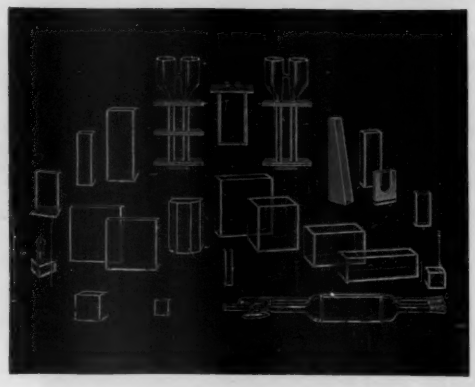

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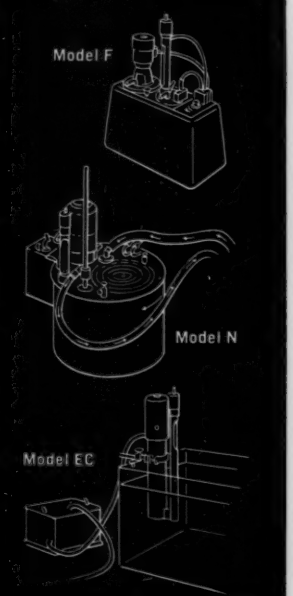

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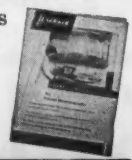

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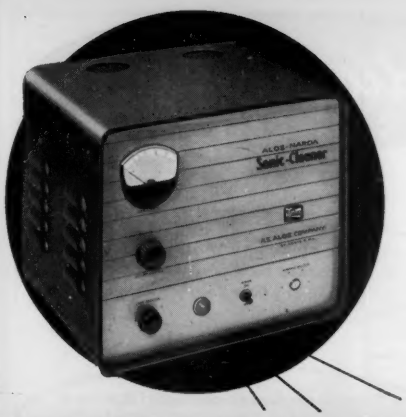

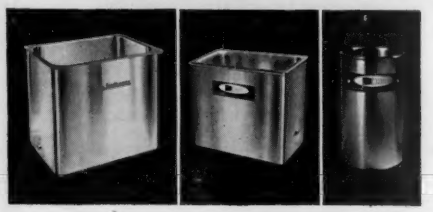

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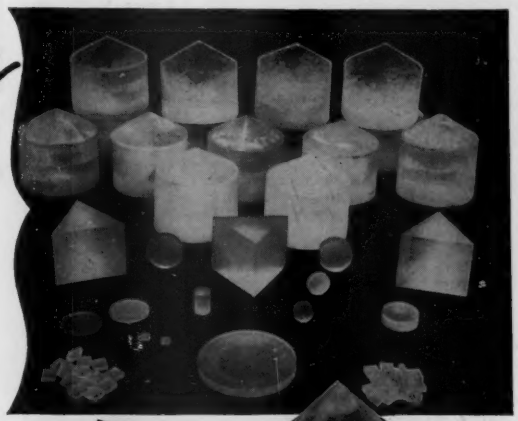

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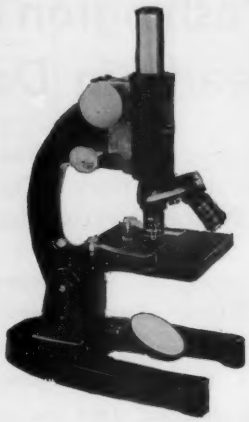

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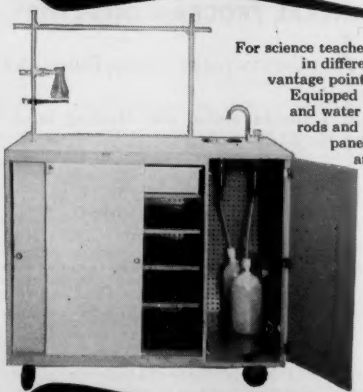

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of the General Program-Directory of the AAAS Washington Meeting by first class mail – early in December

The General Program-Directory of the 125th Meeting of the AAAS in Washington, D.C., Dec. 26–31, 1958, will be available to anyone, at cost, within the first week in December—whether he can attend the Meeting or not. You will want the General Program-Directory for your reference shelf.

Program content

1. The two-session general symposium, "Moving Frontiers of Science III: The Structure of Science and Scientific Organizations Abroad," arranged by the Committee on AAAS Meetings.
2. The six sessions of the Conference on Scientific Communication Problems.
3. Programs of the 18 AAAS sections (symposia and contributed papers).
4. Programs of the more than 90 participating societies.
5. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower, National Geographic Society, Phi Beta Kappa, Sigma Xi, RESA.
6. Details of the Sheraton-Park Hotel—center of the Meeting—and of the other hotels and session sites.
7. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
8. Exhibitors in the 1958 Annual Exposition of Science and Industry and descriptions of their exhibits.

Directory content

1. AAAS officers, staff, committees for 1958.
2. Complete roll of AAAS presidents and their fields.
3. The 279 affiliated organizations.
4. Historical sketch and organization of the Association; the Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards—including all past winners.
7. Membership figures by sections.
8. Section committees (Council members) in detail.
9. Local committees.
10. Future Meetings of the AAAS through 1962.
11. New and current activities of the AAAS.

Advance Registration

Advance registration has these decided advantages: 1) You avoid delay at the Registration Center upon arrival; 2) You receive the General Program-Directory in ample time to decide, unhurriedly, which events and sessions you particularly wish to attend; 3) Your name is posted in the Visible Directory as the Meeting opens.

The following coupon may be used both by advance registrants and by those who wish only the advance copy of the General Program-Directory.

— THIS IS YOUR COUPON FOR AN ADVANCE COPY OF THE GENERAL PROGRAM-DIRECTORY —

1a. ☐ Enclosed is $3.00 for my advance Registration Fee which brings me the Program-Directory, Convention Badge, and all privileges of the Meeting.

1b. ☐ Enclosed is $2.00 for only the Program-Directory. (It is understood that, if I should attend the Meeting later, the Badge—which is necessary for all privileges of the Meeting—will be secured for $1.00 more.)
(Check one)

2. FULL NAME (Dr., Miss, etc.) .....
(Please print or typewrite) (Last) (First) (Initial)

3. ACADEMIC, PROFESSIONAL, OR BUSINESS CONNECTION .....

4. OFFICE OR HOME ADDRESS .....
(For receipt of Program-Directory)

5. YOUR FIELD OF INTEREST .....

6. CONVENTION ADDRESS .....
(May be added later, after arrival)

Please mail this Coupon and your check or money order for $3.00 or $2.00 to the
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
1515 Massachusetts Avenue, N.W., Washington 5, D.C.

PERSONNEL PLACEMENT

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Replies to blind ads should be addressed as follows:
Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

FELLOWSHIPS

NATIONAL RESEARCH COUNCIL OF CANADA POSTDOCTORATE FELLOWSHIPS 1959–60

Approximately 90 fellowships will be awarded for 1959–60 by the National Research Council. Of these, 40 will be tenable in National Research Council Laboratories in Ottawa, Saskatoon, and Halifax; 10 in laboratories of the Canada Department of Agriculture, located at various centers; 10 in laboratories of the Canada Department of Mines and Technical Surveys in Ottawa and Victoria; and 30 in laboratories of Canadian universities.

Applicants should not be more than 35 years of age and should possess a Ph.D. degree from a recognized university, or expect to obtain such a degree before taking up an award. There are no restrictions regarding nationality of applicants, but successful candidates must meet all Canadian immigration requirements.

The annual stipend, which is free of income tax, is $3700 for single fellows and $4500 for male fellows who are married. An allowance towards the cost of travel is also paid.

The fields in which fellowships are available in the laboratories of the National Research Council, the Department of Agriculture, and the Department of Mines and Technical Surveys, are described in greater detail in booklets that may be obtained on request, together with application forms. Applicants who are interested in fellowships in the universities may write directly to these institutions, or to the National Research Council for information. The fields of interest should be stated in the initial inquiry in order that appropriate information may be supplied. The closing date of the competition is **15 February 1959.**

Inquiries should be addressed to Awards Officer, National Research Council, Ottawa 2, Canada. X

POSITIONS OPEN

Bacteriologist, Pharmacologist, or Pharmaceutical Chemist, preferably Ph.D., willing to direct expansion and growth of a microbiological department within a diversified independent laboratory. Position requires a high order of scientific competence coupled with client development ability. Salary will parallel experience and ability. Location, New York metropolitan area. Box S 415, 125 W. 41 St., New York City. X

(a) Chemist; supervisory position in chemistry section of research department, large industrial company; college town, Pennsylvania; Ph.D. preferred. **(b) Analytical Chemist** with 4 to 5 years' experience in pharmaceutical control work and, too, experience in supervising technical staff; Massachusetts. **(c) Industrial Hygienist;** preferably with B.S. degree, chemistry major; 1 year graduate study in industrial hygiene with basic training in epidemiology and biostatistics, industrial health, environmental physiology and industrial toxicology; foreign appointment; $1150 per month. **(d) Physiologist** to join staff of university in process of establishing basic science or biochemical research unit; preferably men qualified to direct this unit; $800–$10,000 fringe benefits. **(e) Advertising Manager;** pharmaceutical company; East; $9000–$11,000. S11-1 Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

POSITIONS OPEN

(a) Clinical Microbiologist; M.D., Ph.D. to supervise bacteriology, developmental work in microbiology and research; outstanding very large diagnostic clinic, affiliated hospital; substantial salary; mideastern university center. **(b) Biochemist;** M.S., Ph.D. to head section; 400-bed, fully approved general hospital; new laboratory, diagnostic center to be occupied early in 1959; to $9000; East. **(c) Bacteriologist;** head expanding department, busy laboratory of 300-bed hospital; midwestern college city 50,000. **(d) Biochemist;** B.S., M.S.; 300-bed hospital; to $6000; residential suburb Pennsylvania university city. **(e) Chief Biochemist;** outstanding opportunity for M.S., Ph.D. to head laboratory, prominent 25-doctor clinic, affiliated 200-bed hospital; also maintain separate research laboratory; residential community near large city; Midwest. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

POSITIONS OPEN

New World-Wide Graduate Award Directories for American scientists, teachers, librarians to subsidize their education and research. Stipends $200–$10,000. Volume I (1957), $3; volume II (just published, no duplication), $3; both volumes, $5. Limited editions. Complete, specific information on 400 awards in United States and overseas in each volume. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. eow

POSITIONS WANTED

Scientist, B.S. in agriculture; interested in assignment involving product or quality control; 11 years on staff major pharmaceutical company, 4 years, supervisor penicillin extraction; 6 years, bacteriology and quality control. Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

USE THIS EASY SELF-MAILER to obtain further information

7 November 1958

Readers' Service

Information Requisition

It's Simple: Mark—Clip—Fold—Mail—No stamp required

This coupon is for your convenience—to facilitate your requests for further information about advertised products and items in Equipment.

From:

Name .... **Position** ....

Company .....

Street .....

City ..... **Zone** .... **State** .....
(Please print or type)

Mark, clip coupon — FOLD HERE along this line — mail

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit #12711 New York, N.Y.

Readers' Service

To: SCIENCE MAGAZINE
Room 740
11 West 42 Street
New York 36, New York

Fasten Here Only
Staple, Tape, Glue

The Market Place

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

DISPLAY: Rates listed below—no charge for Box number. Monthly invoices will be sent on a charge account basis — provided that satisfactory credit is established.

Single insertion	$26.00 per inch
13 times in 1 year	24.00 per inch
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PROFESSIONAL SERVICES

Histology for Industry and Research
George L. Rozsa, M.D.
143 Linwood Ave. Buffalo 9, New York

WISCONSIN ALUMNI RESEARCH FOUNDATION

LABORATORY SERVICES
for the FOOD, FEED, DRUG and CHEMICAL INDUSTRIES
Analyses, Biological Evaluation, Toxicity Studies, Insecticide Testing and Screening, Flavor Evaluation.
Project Research and Consultation
Write for Price Schedule
P. O. Box 2217 • Madison 1, Wis.

PROFESSIONAL SERVICES

AUTHORS WANTED BY N.Y. PUBLISHER

New York, N.Y. — One of the nation's largest book publishers is seeking book-length manuscripts of all types — fiction, non-fiction, poetry. Special attention to new writers. For more information, send for booklet 28A — *it's free.* Vantage Press, 120 W. 31 St., New York 1. (*Branches in: Washington, D.C., Chicago, Hollywood, Calif.*)

CONSULTATION, RESEARCH, DEVELOPMENT
For Drug, Food, Cosmetic and Chemical Industry
CONTRACT RESEARCH PATHOLOGY.
CLINICAL EXFOLIATIVE CYTOLOGY.
INBRED & HYBRID QUALITY HAMSTERS.
Contact without obligation
BIO-RESEARCH CONSULTANTS
9 Commercial Avenue, Cambridge, Mass.
Un 4-8735
F. Homburger, M.D., Director; P. Bernfeld, Ph.D., Director of Research; H. J. C. MacMillan, M.D., Pathologist; R. Whitney, Ph.D., Director of Animal Production

BOOKS AND MAGAZINES

Your sets and files of scientific journals
are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A3S, CANNER'S, Inc. Boston 20, Massachusetts

SCIENTIFIC JOURNALS WANTED
Sets, Runs and Volumes bought at top prices. Your wants supplied from our Back Files of over 3,000,000 periodicals.
Abrahams Magazine Service; N. Y. 3, N. Y.

SUPPLIES AND EQUIPMENT

Sprague-Dawley, Inc.
Pioneers in the development of the standard laboratory rat.
Sprague-Dawley, Inc.
P.O. Box 2071, Madison 5, Wisconsin
Phone: CEdar 3-5318

TRYPSINIZED MONKEY KIDNEY SUSPENSION — MONKEY WHOLE BLOOD — SERUM
Cell suspension packed in wet ice—shipped via air express—growth guaranteed
WRITE OR WIRE
RESEARCH SUPPLY COMPANY
230 Hillside Avenue — Paramus, N.J.

WHITE MICE
Hamsters, Guinea Pigs and Rats
J. E. STOCKER Box 4 Ramsey, N.J.

SWISS MICE
BACTERIOLOGICAL AND GROSS TISSUE STUDY TECHNIQUES USED IN OUR QUALITY CONTROL
HUNTINGDON FARMS, INC.
2548 NORTH 27th ST. PHILA. 32, PA.

ALBINO RATS
SWISS MICE
Price lists on request
DAN ROLFSMEYER CO.
Ph. ALpine 6-6149
Route 3, Syene Road, Madison, Wisconsin

7 November 1958

Readers' Service

Information Requisition

Use this easy self-mailer to obtain further information about items or literature from the Equipment section as well as from advertised products.

EQUIPMENT

Circle below desired number corresponding to:

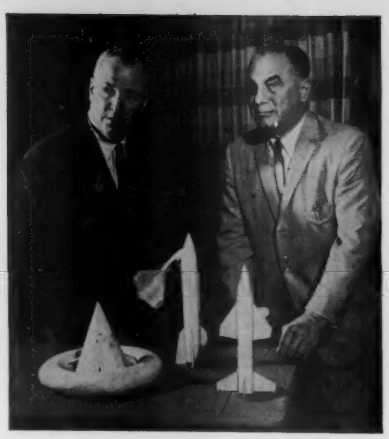
437 445 446 451 452 455 458 459
460 461 463 464 466 467

ADVERTISERS IN THIS ISSUE

In list below, check page number of advertiser from whom you would like more information. If more than one item appears in ad, letters (A, B, C) are used to indicate particular items available in order of appearance in advertisement. Where more than one ad appears on page, **"U" indicates upper ad, "L" lower ad, "I" inside ad, "M" middle ad,** and **"O" outside ad.** Advertisements in Personnel Placement and Market Place are not keyed. A multiplicity of items is indicated by *. Readers are requested to specify on this coupon the particular item in which they are interested; otherwise, the request cannot be processed.

☐ 1102	☐ 1103, A	☐ 1103, B	☐ 1103, C	☐ 1104
☐ 1105	☐ 1106	☐ 1107	☐ 1108	☐ 1110
☐ 1151, I	☐ 1151, O	☐ 1152, UO	☐ 1152, UI	☐ 1152, LO
☐ 1153	☐ 1155, UI	☐ 1155, UO	☐ 1155, L	☐ 1156, UO
☐ 1156, LO	☐ 1158, A	☐ 1158, B	☐ 1158, C	☐ 1159, UI
☐ 1159, UO	☐ 1159, L	☐ 1160	☐ 1161, U	☐ 1161, L
☐ 1162, O*	☐ 1162, UI	☐ 1162, LI	☐ 1163, UI	☐ 1163, LI
☐ 1163, O*	☐ 1168			

An invitation to senior scientists and engineers



A $14,000,000 R & D Center, housing 9 new laboratories, was revealed as core of Republic's $35,000,000 Research and Development Program at recent announcement by Mundy I. Peale, President, and Alexander Kartveli, Vice-President for Research and Development.

.... To join Republic Aviation's new $35 million Research and Development Program for spacecraft, missiles and advanced aircraft

In announcing Republic's $35 million research and development program, designed to arrive at major breakthroughs in the aviation industry's transition to astronautics, Mundy I. Peale, President, set the following objectives:

"...ACCELERATION OF PROJECTS ALREADY UNDER WAY AT REPUBLIC ON LUNAR PROGRAM FOR MANNED SPACE VEHICLES, AND MISSILES TO DESTROY ORBITING WEAPONS, AND INITIATION OF INVESTIGATIONS LEADING TO NEW CONCEPTS FOR INTERPLANETARY TRAVEL."

"...RADICAL NEW FAMILIES OF LONG-RANGE AIR-TO-AIR MISSILES AND AIR-TO-SURFACE BALLISTIC MISSILES FOR STRATEGIC AND TACTICAL AIRCRAFT."

"...VERTICAL TAKE-OFF FIGHTER-BOMBERS, HIGH-MACH FIGHTER-BOMBERS, AND SUPERSONIC TRANSPORTS."

Alexander Kartveli, Vice-President for Research and Development, emphasized that Republic's program "will not duplicate in any way investigatory work currently in progress elsewhere, but will stress novel concepts and new approaches to basic problems of missiles and space technology."

The program includes construction of a $14 million R & D center to house 9 new laboratories, and anticipates doubling the present research staff.

Senior men interested in the new possibilities created by a simultaneous exploration of all aspects of Flight Technology are invited to study the functions of the new laboratories for more detailed information:

SPACE ENVIRONMENTAL DEVELOPMENT LABORATORY
To simulate space flight conditions and test missile, satellite and spacecraft systems and components; investigate human engineering problems.

RE-ENTRY SIMULATION & AERODYNAMIC LABORATORY
To study hypersonic shock dynamics, real gas effects, heat transfer phenomena and magnetohydrodynamics.

MATERIALS DEVELOPMENT LABORATORY
Study effects of high velocity, temperature, and space environment on materials for spacecraft, missiles and advanced weapons.

GUIDANCE & CONTROL SYSTEM DEVELOPMENT LABORATORY
To develop and test guidance and control systems for spacecraft, missiles and aircraft.

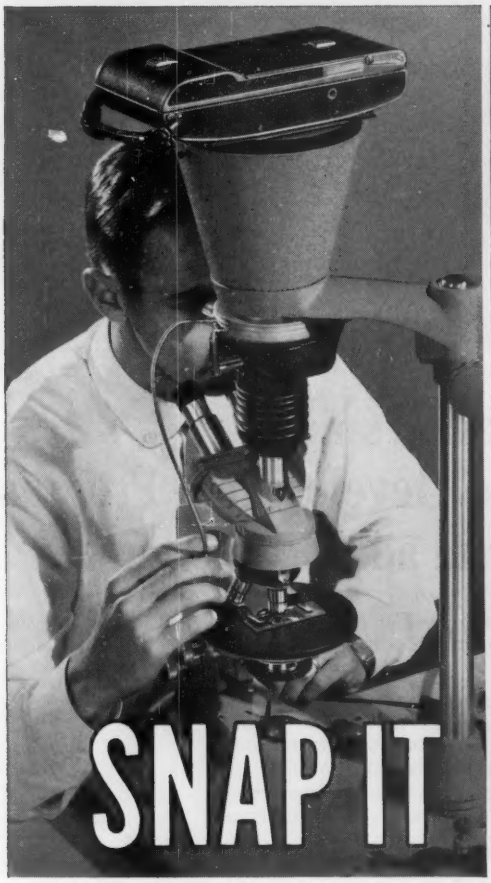
ELECTRONICS DEVELOPMENT LABORATORY
Study and explore all problems connected with highly specialized, complex electronic systems required for advanced forms of spacecraft, missiles and aircraft.

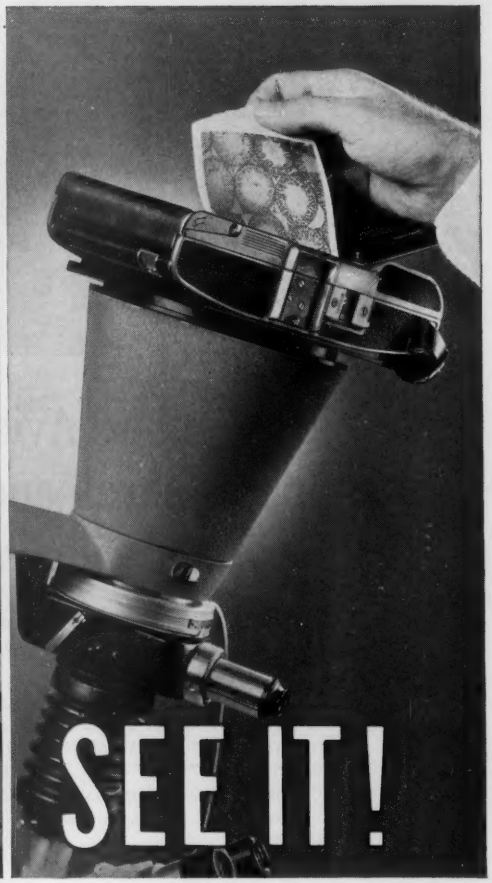
ADVANCED FLUID SYSTEMS DEVELOPMENT LABORATORY
To develop and test fluid power systems for spacecraft and missiles capable of operation under extremely high temperature, high pressure conditions.

MANUFACTURING RESEARCH & DEVELOPMENT LABORATORIES
To develop advanced manufacturing processes and techniques for materials used in missiles and spacecraft. Laboratories for each of the following areas: *Non-Metallics, Metallics, Welding.*

Qualified men are invited to write directly to:
A. Kartveli, Vice President, Research and Development

REPUBLIC AVIATION
FARMINGDALE, LONG ISLAND, NEW YORK





SNAP IT SEE IT!

AO Spencer Picture-in-a-minute Photomicrography

When you use the AO Spencer Photomicrographic Camera equipped with the Polaroid® Land Camera back, permanent photographs are ready for your files in just 60 seconds. A coupled visual and photographic system lets you shoot what you see . . . quickly and effortlessly. And with the Polaroid back possible errors in exposure, illumination or focus can be corrected immediately.

In addition to the Polaroid Land camera back, you have a choice of 4 other *readily interchangeable* camera backs; 4″ x 5″ fixed back; 4″ x 5″ Graflok back; 35mm back and Bantam back (roll film). You choose the camera back and film best suited to your specific requirements.

Here, the No. 682G Camera is being used with the AO Spencer Series 4 Microstar . . . an ideal combination. The built-in base illuminator provides convenient Koehler-type illumination. You select specimen area and do all preliminary focusing through binocular portion of trinocular body . . . focus critically with the telescopic eyepiece.

The sturdy vertical pillar, the easily adjustable camera support, the camera back and the Microstar all combine to provide a compact unit. Perfect alignment and rigidity is assured . . . successful photomicrography becomes a "snap".

Try it and see for yourself. Your AO Representative will be happy to arrange a demonstration for you.

AO SPENCER

American Optical Company

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. K-1

☐ Please send me Brochure SB682 describing the entire line of AO Spencer Photomicrographic Cameras.

☐ Please send me Brochure SB124 describing the new Microstars.

Name_____

Address_____

City_____ Zone____ State____